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The Petroleum Engineer

DALLAS, TEXAS

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DERRICKS PUMPING EQUIPMENT

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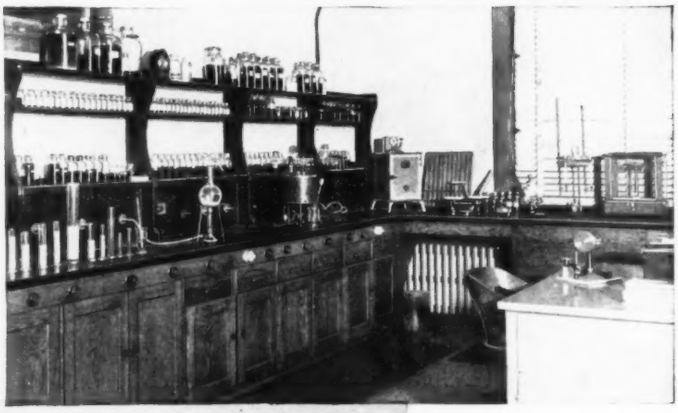
LEE C. MOORE & CO. INC. TULSA · PITTSBURGH

MODERN FACILITIES

Large, modern, adequately equipped and manned research laboratories assure you the utmost economy and dependability in universal and special formulas for treating crude oil to pipe line requirements. Tretolite Advisory Service is quickly available regardless of your location.



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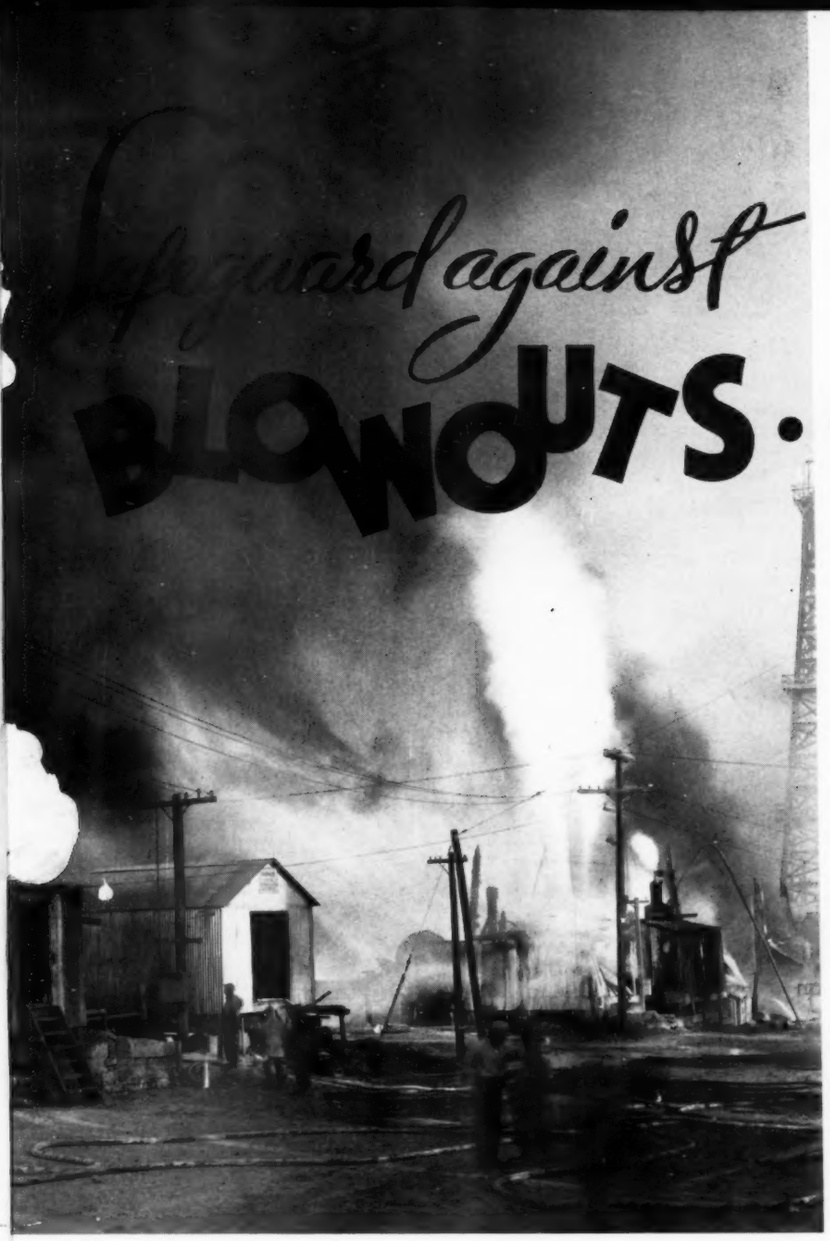
MANUFACTURING CHEMISTS

DALLAS **SAINT LOUIS** **LOS ANGELES**

Representatives in all Principal Fields

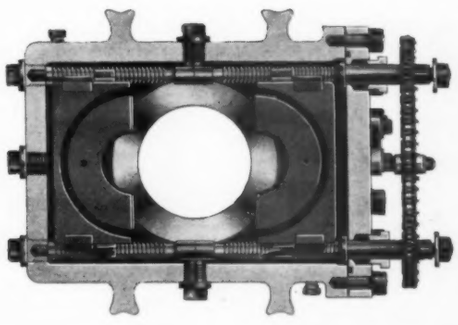


Safeguard against BLOWOUTS . . .

GET POSITIVE PROTECTION

SHAFFER CELLAR CONTROL GATES provide the maximum of safety against blowouts when pipe is either in or out of the hole.

The highest well pressures do not interfere in any way with their operation. They are equipped with steel rams faced with oil-resisting rubber, which are actuated by two steel operating screws, one on either side of the ram. Each operating screw is made with a right-hand thread on one end and a left-hand thread on the other (see cross section drawing). The turning of the operating screws causes both rams to move simultaneously and since the two screws are connected by a chain (see lower illustration) they are revolved in synchronism by movement of either the hand or pelton wheel.



The outstanding feature of the Shaffer Cellar Control Gate shut-off is its unique and positive seal. The sealing action of the rubber is simple and positive in its contact with the inside face of the gate body and where the rams come together, both for complete shut-offs or shut-offs around pipe.

The ease and speed with which the rams are changed is another remarkable feature of Shaffer Cellar Control Gates. Under average conditions it takes only two men one hour to make a complete change of rams.

A Shaffer Cellar Control Gate with rams for complete shut-off will take the place of any drilling gate and offers the advantage of being readily closed even when a well is flowing wildly; also it can be opened easily under any pressure when desired.

SHAFFER TOOL WORKS

BREA, CALIFORNIA • HOUSTON, TEXAS

EXPORT OIL WELL SUPPLY COMPANY

We Can't Be Too Particular . . . .

. . . . *and neither can* YOU!

Some visitors to the South Chester plant have expressed the opinion that perhaps we are "too particular" when it comes to inspection. We don't agree with them!

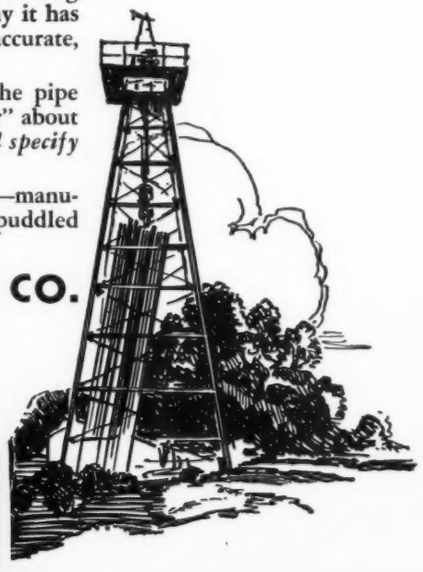
True enough, all Chester pipe *is* given a sevenfold inspection: Hot Inspection in the welding department; Hot Bed where the pipe is weighed; Crop End Test to determine metal quality and strength of weld; Shop Inspection where threads are gauged and taper and pitches are checked. Then comes the Hydrostatic Test—the Final Inspection of surface, field end and couplings—Weight Checking and Shipping.

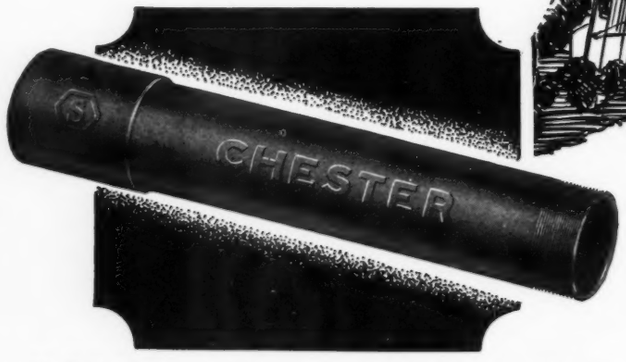
We *are* particular about every phase in the making and inspection of "Chester" Pipe. That's why it has the strength for which it is noted — the accurate, unbroken threads for which it is famous.

But we can't be "too particular" about the pipe *we produce.* And *you* can't be "too particular" about the pipe *you purchase. That's why you should specify Chester!*

Chester also makes "Wrought Iron" Pipe—manufactured from genuine old-fashioned hand puddled muck bar.

SOUTH CHESTER TUBE CO.
Chester, Pennsylvania





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CHESTER

STEEL CASING AND LINE PIPE

The Petroleum Engineer, issued thirteen times a year by the Petroleum Engineer Publishing Co., 405-409 Tower Petroleum Bldg., Dallas, Texas. Subscription price, $1.00 per year, except in Canada, where the price is $1.65 per year—15 cents a copy. Entered as second-class mail matter May 1, 1932, at the post office at Dallas, Texas, under the Act of March 3, 1879.

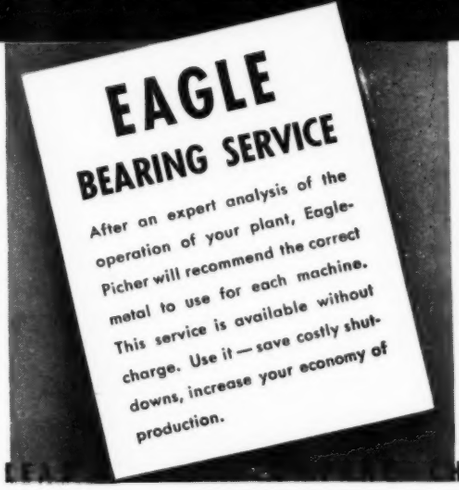
"You mean these 3 BEARING METALS will fill 95% of all our requirements?"
"That's what I mean, John, and EAGLE Metals are absolutely uniform in quality . . . always!"

1. EAGLE DREADNAUGHT • Tough metal for bearings subject to extreme speed and heavy pressure.

2. EAGLE OUTLASTA • General service metal for bearings where even speed and pressure conditions prevail.

3. EAGLE DURABLE • A No. 4 bearing metal for all less severe bearing requirements.

Consult your Eagle Bearing Metal Chart for dependable information on which metal to use in each piece of equipment. If you do not have this Eagle Chart, write today for free copy.


EAGLE
BEARING SERVICE
After an expert analysis of the operation of your plant, Eagle-Picher will recommend the correct metal to use for each machine. This service is available without charge. Use it — save costly shut-downs, increase your economy of production.

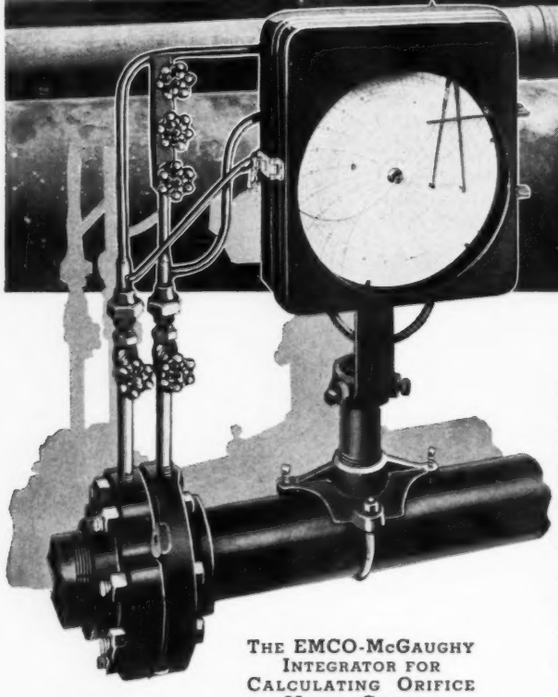
Other Eagle Products used in the oil industry: Eagle Lead Wool and Casings • Eagle Rope Socket Metal • Eagle Sheet Lead • Eagle Insulation • Eagle Sublimed Litharge • Eagle Sublimed Blue Lead.

THE EAGLE-PICHER [illegible] HICAGO · JOPLIN · CINCINNATI

EMCO ORIFICE METERS

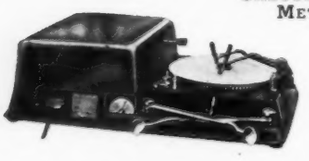
for

Natural Gasoline Plants

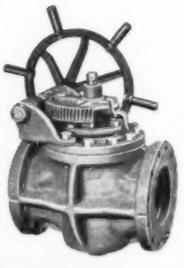


THE EMCO-McGAUGHY INTEGRATOR FOR CALCULATING ORIFICE METER CHARTS

EMCO Orifice Meters, unique in design and constructed of the finest materials including the liberal use of special alloys and stainless steel, to prevent corrosion, are being installed by experienced Natural Gasoline Plant Operators everywhere. Accessibility to all working parts is a big factor, likewise, the one piece welded manifold. Write for Bulletin 1013 —it describes fully the features of EMCO Orifice Meters.



The EMCO-McGaughy Integrator presents the only present known method of obtaining EXACT calculation of the extension of Orifice Meter Charts. With it chance of human error is eliminated entirely and chart calculations are speeded up to the extent that one operator with an EMCO-McGaughy Integrator can calculate four times as many charts as can be done by the inspection method in the same given time.



EMCO-NORDSTROM VALVES, FOR GATE VALVE REPLACEMENT

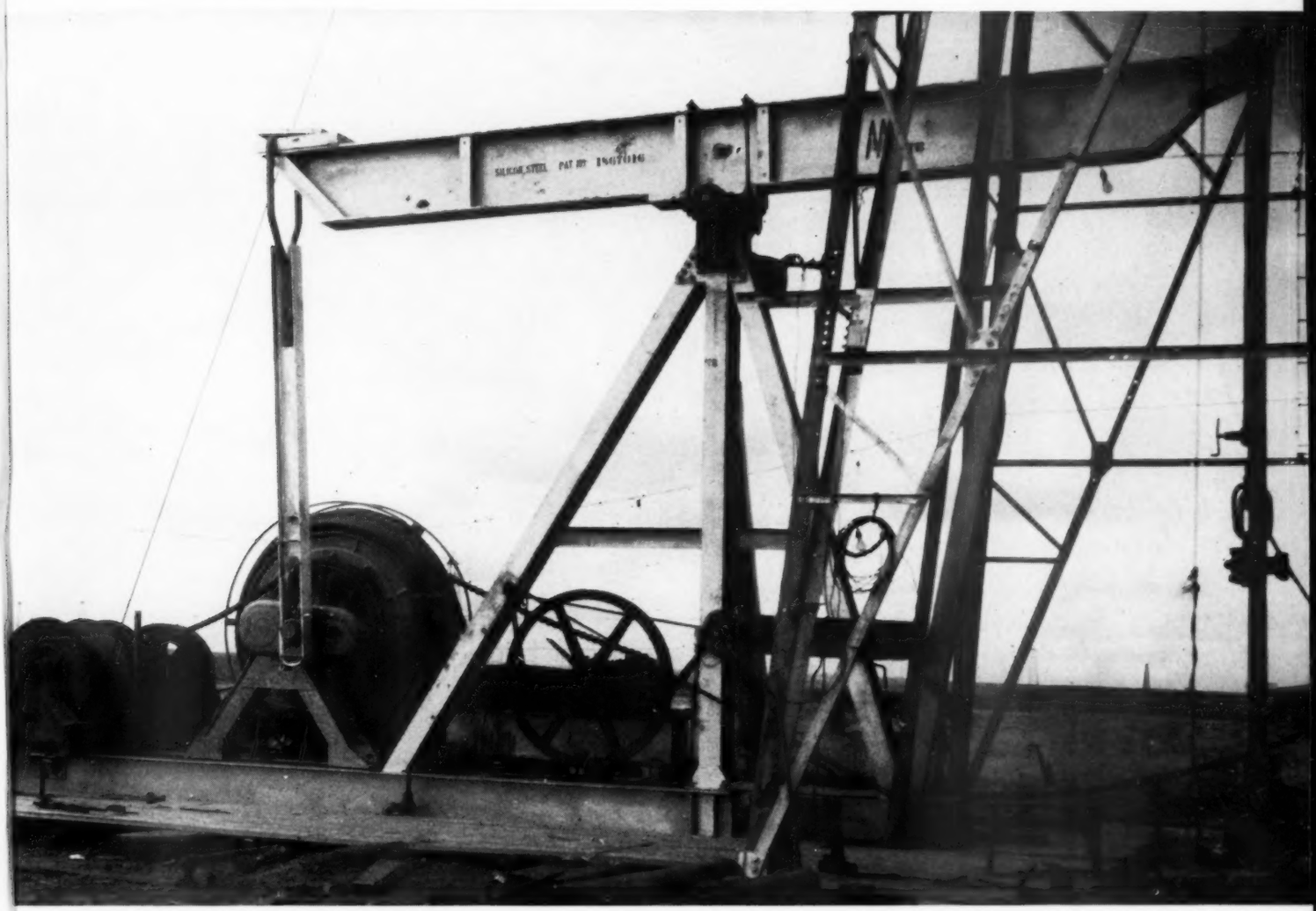
PITTSBURGH EQUITABLE METER CO.

MERCO NORDSTROM VALVE CO.

MAIN OFFICES PITTSBURGH, PA.

ATLANTA · BUFFALO · CHICAGO · MEMPHIS
NEW YORK · COLUMBIA · KANSAS CITY · PHILADELPHIA · TULSA · HOUSTON · LOS ANGELES · OAKLAND

For Drilling "FROM TOP TO BOTTOM"



O.C.S. Portable Rig Front Installation With Sand Reel Hook-Up in Panhandle, Gray County, Texas

FOR CLEANING OUT--DRILLING DEEPER SWABBING AND TEMPORARY PUMPING

- A Compact Transmission designed to replace conventional standard rig.
- Replaces Standard Rig for Driving Bullwheel, Calfwheel, Sand Reel and Hoist.
- Highway Portability, being within road limits of 8' x 25'.
- Use any type prime mover available in the oil country.
- Particularly adapted for standard oil country steam engine or electric motor.
- For Cable Tool Drilling, Before or After the Rotary.
- Quick, Easy, Economical Movement from Rig to Rig—Field to Field.
- Oil Bath Saddle Bearing.
- Oil Seal Wrist Pin.
- Accurately Machined Sprockets.
- Diamond Roller Chain.
- 7' Double Tug with Guards.

OCS

For Steam, Electric, Gas or Oil Power

PORTABLE RIG FRONT

See Page 1001 — 1936 Composite Catalog or Write for Bulletin — P. R.

Our products described in the COMPOSITE CATALOG

Manufactured By

THE OIL COUNTRY SPECIALTIES MFG. CO.

COFFEYVILLE, KANSAS, U. S. A.
McPherson, Wichita, Kansas. Pampa, Fort Worth, Kilgore, Texas.

LONG BEACH, CALIFORNIA, U. S. A.
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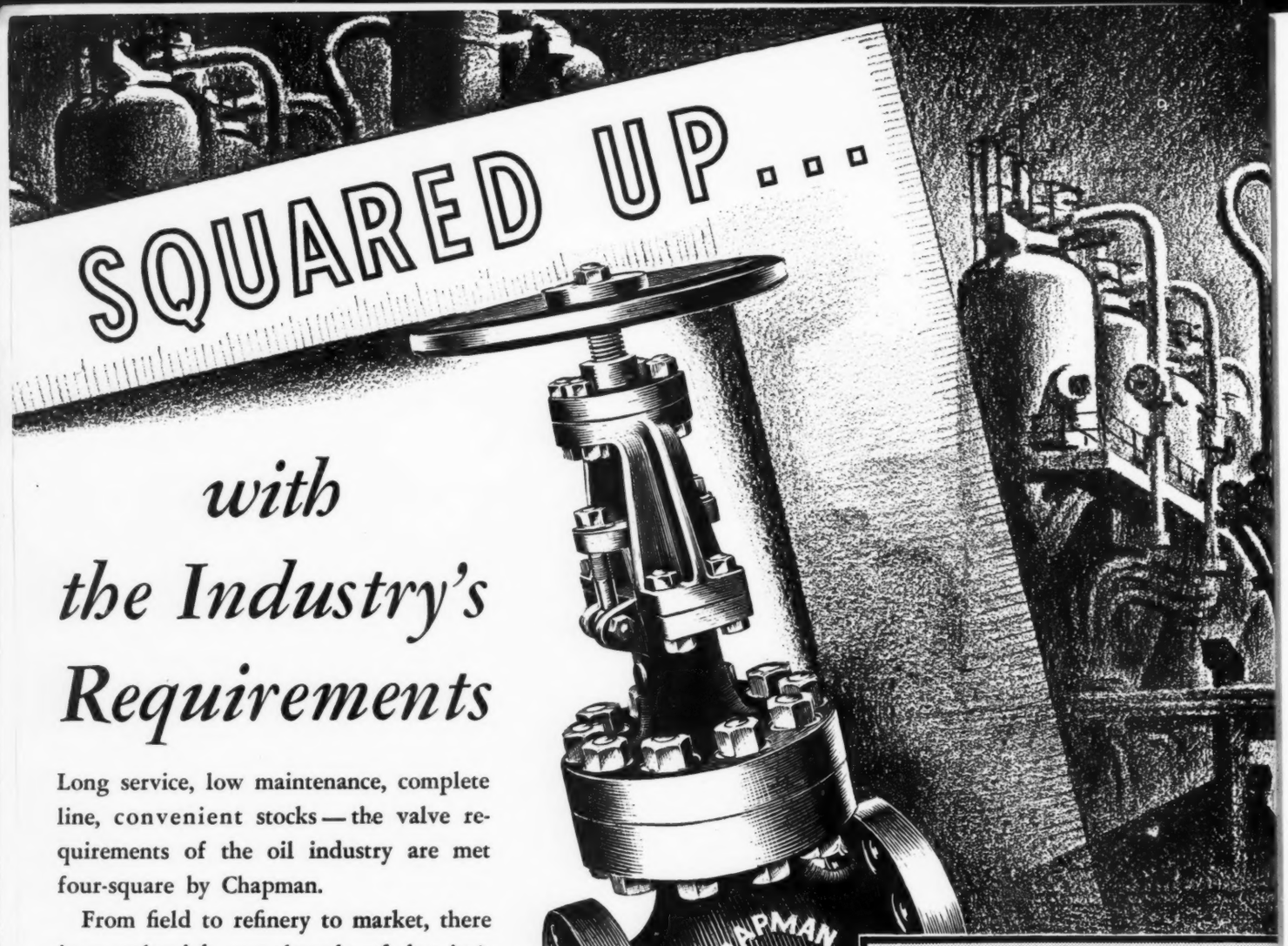


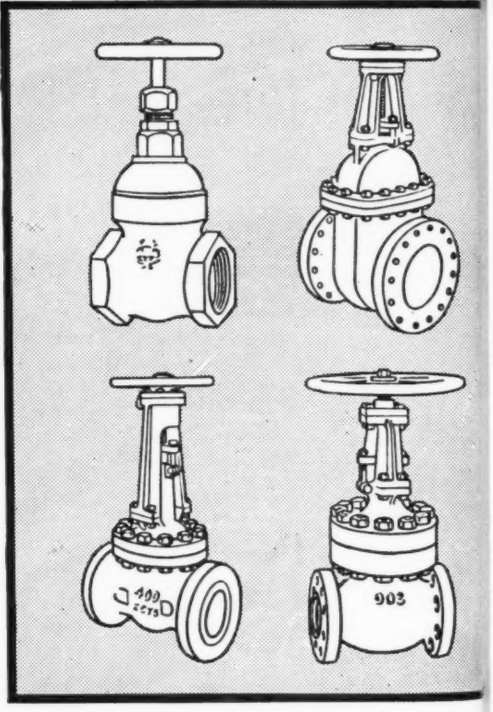
with the Industry's Requirements

Long service, low maintenance, complete line, convenient stocks — the valve requirements of the oil industry are met four-square by Chapman.

From field to refinery to market, there is no valve job ever thought of that isn't being handled by Chapmans—by the thousand—all over the world. And that means staying on the line with unvarying efficiency year after year, under extremes of pressure and temperature, without any danger of failure or creep.

For special conditions there are valves of special patented metals developed by Chapman in close co-operation with petroleum engineers. No job can be *too* special, for you will find in Chapman's standard line the exact valves you need for every application. Gate, globe and check valves, with fittings, in all sizes. For pressures from 150 to 1500. Temperatures from 50° below to 1500° above.

There are stocks located near you, on which you can always depend for delivery. Talk it over with your supply man — or write to Indian Orchard for full information.



The CHAPMAN VALVE MANUFACTURING COMPANY

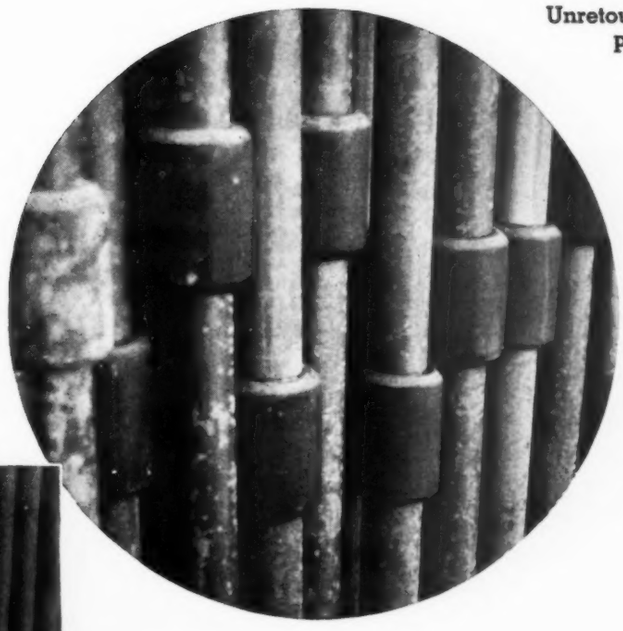
INDIAN ORCHARD, MASSACHUSETTS

Another talked-about drilling job

Gibson No. 1

Belridge Field, California

Unretouched Photos



Using All-Rubber Protectors on Upset Tool Joints

Here's a test that's a REAL test for Protectors. The above photo shows 3½" full hole tool joints on 2⅞" drill pipe. The Patterson-Ballagh Protectors were expanded 400% to slip over the tool joints. They have held perfectly month after month under conditions of extreme temperature existing in the Belridge Field in California.

PATTERSON-BALLAGH PROTECTORS

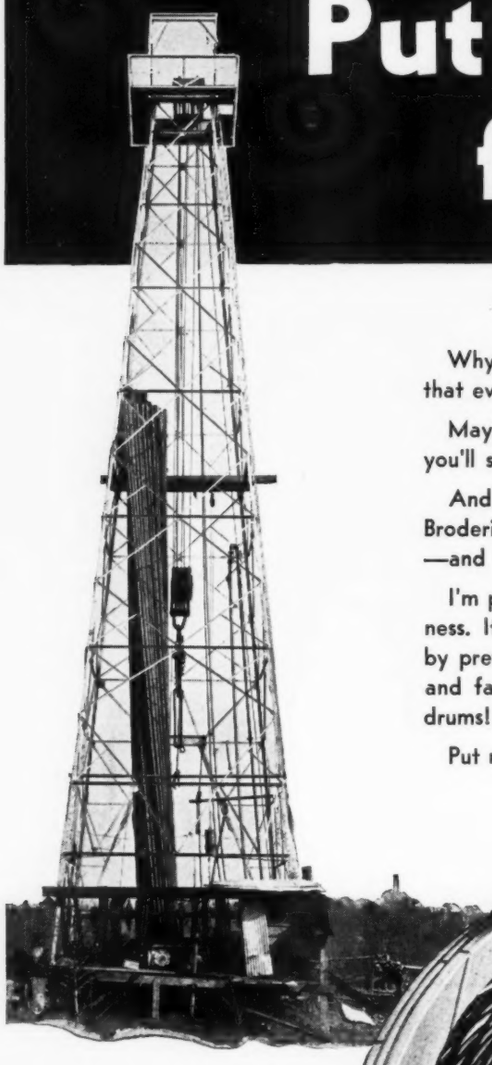
—of course

Patterson-Ballagh Corporation

Plant and General Offices: 1900 East Sixty-fifth Street, Los Angeles, Calif., U. S. A. *Texas and Gulf Coast Distributors:* Bettis Sales Company, 515 Merchants & Manufacturers Bldg., Houston, Texas. *Oklahoma Office:* 438 Northwest Twenty-sixth Street, Oklahoma City, Okla. *New York Office:* 39 Cortlandt Street. *Fresh Stocks Carried at:* Casper, Wyo.; Oklahoma City, Ada, Okla.; Lake Charles, Houma, La.; Hobbs, N. Mex.; Houston, Odessa, Texas; Kettleman Hills, Bakersfield, Ventura, Los Angeles, California. Sold by all Supply Houses.

The Crew—The boys who are doing the drilling at Gibson No. 1. Left to right: Tool Pusher Mitchell, Driller Hutchins and Crew.

Put ME to work for YOU!



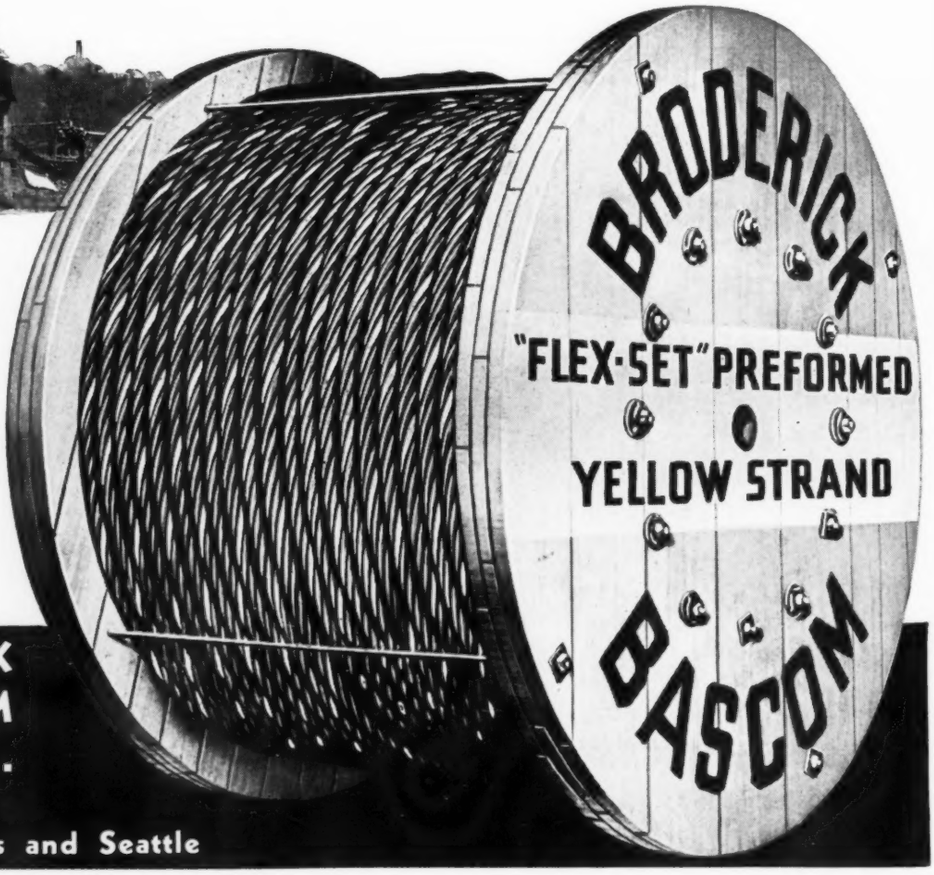
Why not? I'm "Flex-Set" Preformed Yellow Strand, the toughest rope that ever ran and landed a string of casing.

Maybe you think I'm boasting. Well, just put me to work for you and you'll soon find out how tough I am.

And why shouldn't I be tough? My wires are especially drawn to Broderick & Bascom's specifications. And are those specifications HIGH —and exacting! I'll say they are!

I'm preformed, which adds a lot of other good qualities to my toughness. It makes me limber — easy to handle and install. What's more, by preforming, I'm practically pre-broken in, so you can work me hard and fast soon after putting me on. And how I do resist crushing on drums! You'll be surprised.

Put me to work for you right now. . . . I'm tough.



The Continental Supply Co.

Mid-Continent and Rocky Mountain Distributors

T-20R1

BRODERICK & BASCOM ROPE CO.
ST. LOUIS

Factories: St. Louis and Seattle

SHALLOW *or* DEEP

Depth doesn't stop us. From the deepest fields to the shallowest areas YOUNGSTOWN Drill Pipe, Casing and Tubing is famed for the economies which Youngstown "matched thread perfection" makes possible in installation and maintenance, and the dependable performance built into every length of Youngstown Oil Country Tubular Goods.

THE YOUNGSTOWN SHEET AND TUBE COMPANY
Manufacturers of Carbon and Alloy Steels
General Offices - YOUNGSTOWN, OHIO

Youngstown's Pipe is distributed by --
THE CONTINENTAL SUPPLY COMPANY, Dallas, Texas
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REPUBLIC SUPPLY CO. OF CALIFORNIA, Los Angeles
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TRADE MARK
YOUNGSTOWN

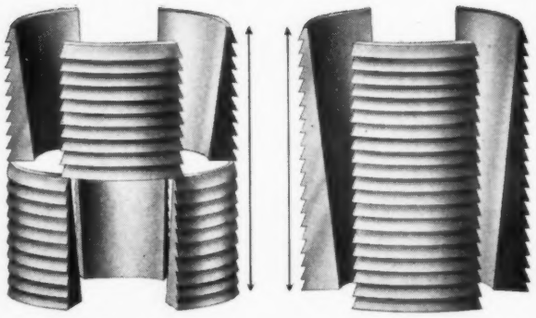
388

Both have the same basically correct slip area

CORRECT *Slip Area*

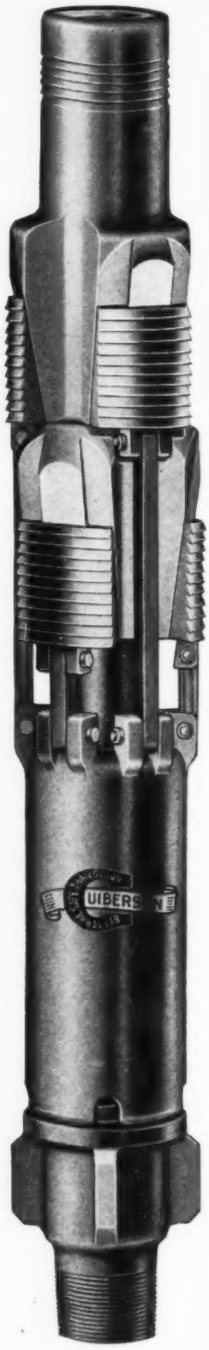
FOR DEEPEST WELLS

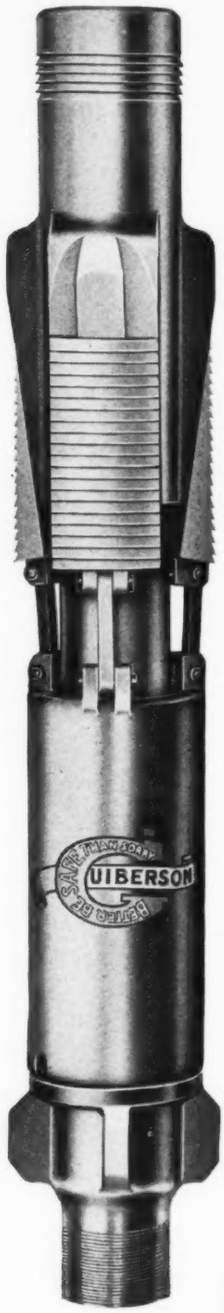
- INSTANT GRIP
- SAFETY FOR CASING
- QUICK RELEASE
- MAXIMUM BY-PASS



GUIBERSON "DUPLEX"

GUIBERSON "TYPE E"





GUIBERSON Catcher slips have always been of CORRECT size to handle the maximum loads imposed.

When the present era of deep drilling began, GUIBERSON engineers approximately *doubled* the area of GUIBERSON Catcher slips. Thus the newest models, here shown, continue the GUIBERSON policy of providing slips of CORRECT size to handle maximum loads.

Slip areas of our Type "A" and "B" models are ample for wells of average depth. Slip areas of the "Duplex" and "Type E", here shown, are ample for wells of any depth.

GUIBERSON Tubing Catcher Anchor

These newer models, as here indicated, have approximately the same total slip area. Some operators prefer the "Duplex" type because it distributes the load around the entire 360 degrees of the casing's inner circumference.

Through 23 years of field experience, every detail of this catcher's construction has been perfected. Among its features are (1) Ample by-pass area, (2) All load-carrying parts of machined steel, (3) Springs of specially developed steel which will not fatigue, (4) Instant grip, (5) Easy release.

The GUIBERSON sold the tubing catcher idea. It is in use wherever oil is produced.

Over 100,000 GUIBERSON Tubing Catchers in use, in both domestic and foreign oil fields today.

See the GUIBERSON complete catalog in 1936 Composite Catalog, pages 547 to 574.

THE GUIBERSON CORPORATION

Box 1106, Dallas, Texas

TULSA: 504 Wright Bldg.; HOUSTON: 1635 Norfolk St.;
PONCA CITY: 321 Osage St.; NEWARK, O.: First and Locust Sts.
LOS ANGELES: W. R. Guiberson Company, 723 E. Gage Ave.

GUIBERSON

BETTER BE SAFE THAN SORRY

AMERICAN TIGER BRAND WIRE LINES

THE TIGER *puts his Foot Down on Excessive Costs!*

THE TIGER trade mark for genuine American Tiger Brand wire lines tells a story of savings that extend over maximum periods... performance proved in service . . . quality developed for your specific needs.

AMERICAN TIGER BRAND WIRE LINES

ELECTRICAL WIRES & CABLES

AMERCLAD ALL-RUBBER CABLES

TIGER WIRE ROPE CLIPS

WIRE ROPE FITTINGS

AMERICAN STEEL & WIRE COMPANY

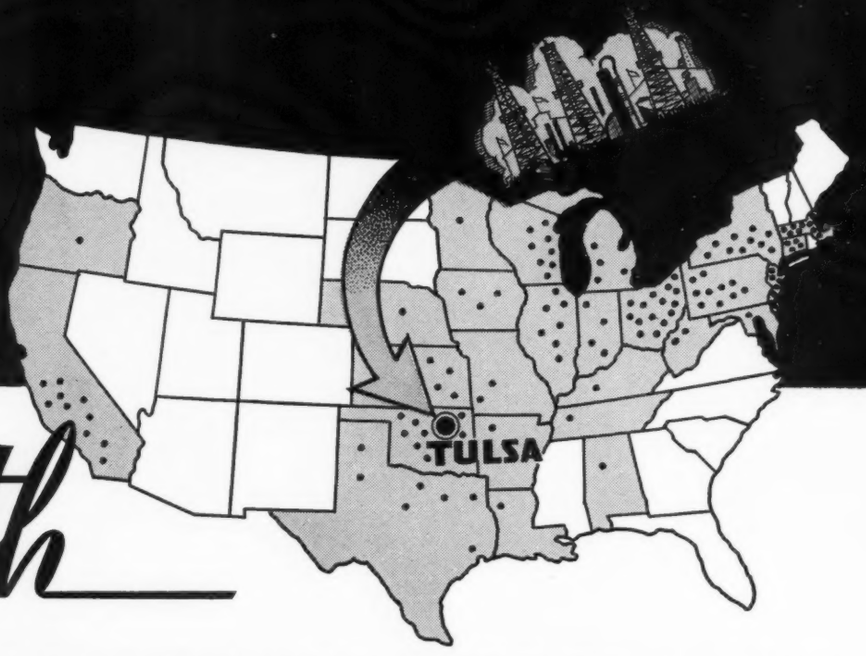
208 S. La Salle Street, Chicago Empire State Building, New York

Pacific Coast Distributors: Columbia Steel Co., San Francisco

Export Distributors: United States Steel Products Co., New York City

UNITED STATES STEEL

A TEN MILLION DOLLAR SHOW



9th INTERNATIONAL PETROLEUM EXPOSITION

TULSA May 16-23, 1936

The Oil Fraternity of the World is headed for "The World's Fair of the Oil Industry" to again inspect the latest advancements in its scientific, technical, producing, refining, transportation and marketing—contributions made to the improvement of the great Petroleum Industry by the laboratories, research institutions, mills, shops and factories serving the industry.

Tulsa will again be the "nerve center" of the oil industry—"headquarters" for executives, engineers, superintendents, purchasing agents and field men from every oil producing state—every oil producing nation in the world. Special reduced railroad rates apply. Ask for complete information. Plan now to attend. You can't afford to miss it. Write the special housing committee for hotel reservations.

WM. B. WAY, General Manager

Phone 4-2092 Tulsa, Oklahoma, U.S.A.

The World's Fair of the Oil Industry

PAY YOURSELF A BONUS

USE BAROID PRODUCTS AND SAVE!

BAROID SAVES

BAROID-weighted muds control oil, gas and water pressures encountered in drilling, and when properly used, hold in place formations which tend to cave or slough into the hole. BAROID will not settle from the mud even though circulation is suspended for long periods of time. Pumpable muds weighing as much as 145 pounds per cubic foot can be prepared from BAROID.

Stocks carried and Service Men available in all active oil fields.

AQUAGEL SAVES

Each ton of AQUAGEL makes from 140 to 180 barrels of excellent drilling mud. When properly used, AQUAGEL prevents caving, loss of circulation, stuck drill pipe and casing; reduces abrasion; suspends drilling mud solids and seals off fissures, caves and minor flows of gas and water.

AQUAGEL-cement is used to plug crevices; restore lost circulation; set casing; straighten crooked holes; side track tools and seal off high-pressure water areas.

Stocks carried and Service Men available in all active oil fields.

STABILITE SAVES

STABILITE reduces the viscosities of thick drilling muds without destroying their wall-building properties. Permanent and greater final viscosity reductions, with less chemical, can be obtained with STABILITE. Muds treated with STABILITE quickly release gas from gas-cut muds. STABILITE presents no hazards in mixing or handling and assures lower mud-treating costs. Sold in liquid or powder form.

Stocks carried and Service Men available in all active oil fields.

BAROCO SAVES

BAROCO makes 40 barrels of excellent 15 centipoise viscosity drilling mud per ton, approximately two or three times as much mud as can be made from one ton of commercial native clays, with a resultant saving of approximately 25% to 50% per barrel. It builds a better wall and builds it more quickly than ordinary clays, and resists the "flocculating" action of salt and salt waters.

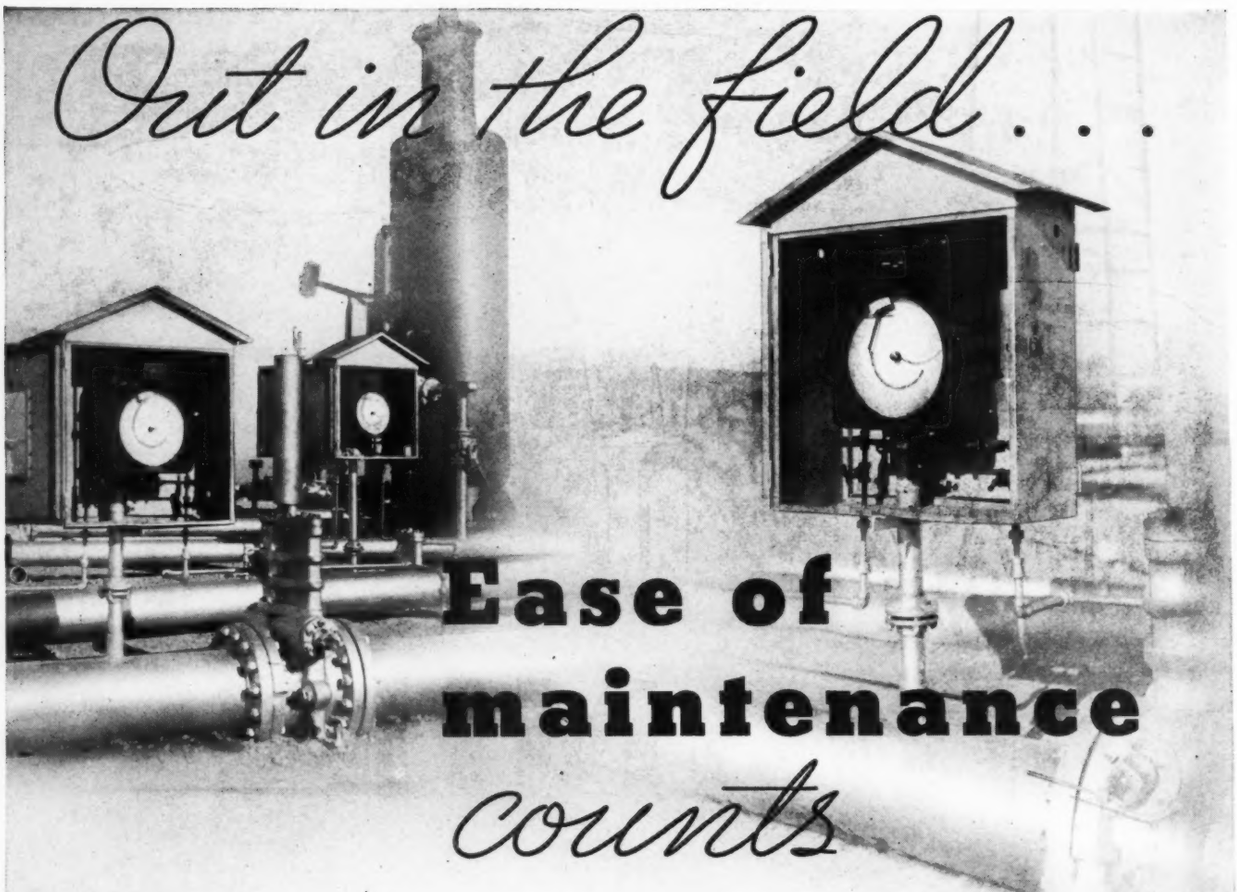
Stocks carried in Mid-Continent and Gulf Coast oil fields only.

BAROID SALES COMPANY

LOS ANGELES • HOUSTON

NATIONAL PIGMENTS & CHEMICAL COMPANY, ST. LOUIS

HOUSTON APR. 20-25 SEE OUR EXHIBIT OIL EQUIPMENT & ENGINEERING EXPOSITION



Ask the practical field engineer what he thinks of any meter, and he will tell you in terms of how little attention it needs . . . how easy it is to keep in proper adjustment.

That's why you see so many more WESTCOTT orifice meters out in the field where there's no time for coddling instruments.

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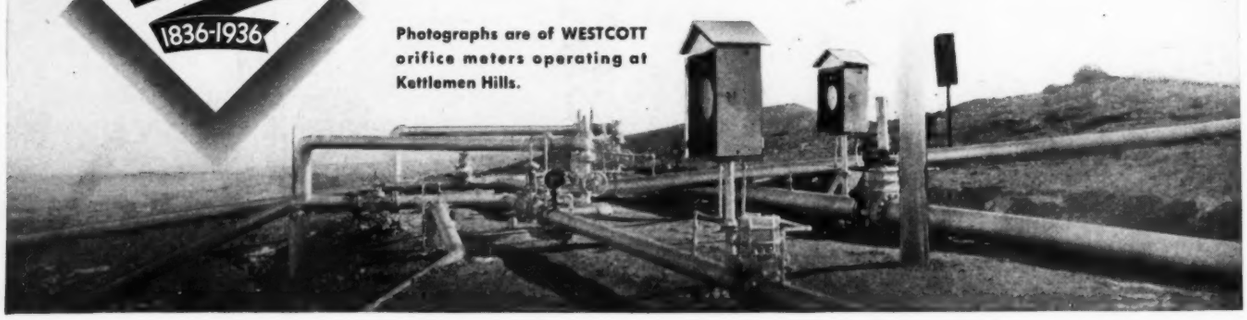

THE Petroleum Engineer

MARCH 1936

VOLUME VII NUMBER VI

A MAGAZINE OF METHODS FOR OPERATING MEN

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Meetings

California Natural Gasoline Association—April 2, Richfield Building, Los Angeles.

Western Petroleum Refiners Association, Annual Meeting—April 9 and 10, Excelsior Springs, Missouri.

American Petroleum Institute, Division of Production, Southwestern District—April 9 and 10, Washington-Youree, Shreveport, Louisiana.

Petroleum Industry Electrical Association—April 11, 12, and 13, Tulsa, Oklahoma.

Pacific Coast District, Division of Production, American Petroleum Institute, Spring Meeting—April 14, Los Angeles, California.

Oil Equipment and Engineering Exposition—April 20, 21, 22, 23, 24, and 25, Houston, Texas.

Natural Gasoline Association of America, Annual Meeting—May 13, 14, and 15, Mayo Hotel, Tulsa, Oklahoma.

American Petroleum Institute, Mid-Year Meeting—May 13, 14, and 15, Tulsa, Oklahoma.

International Petroleum Exposition —May 16-23, Tulsa, Oklahoma.

Independent Petroleum Association of America, Mid-Year Meeting—May 21, Tulsa, Oklahoma.

National Stripper Well Association, Annual Meeting—May 22, Tulsa Oklahoma.

American Society of Mechanical Engineers, Semi-Annual Meeting—June 15, 16, 17, 18, 19, and 20, Dallas, Texas.

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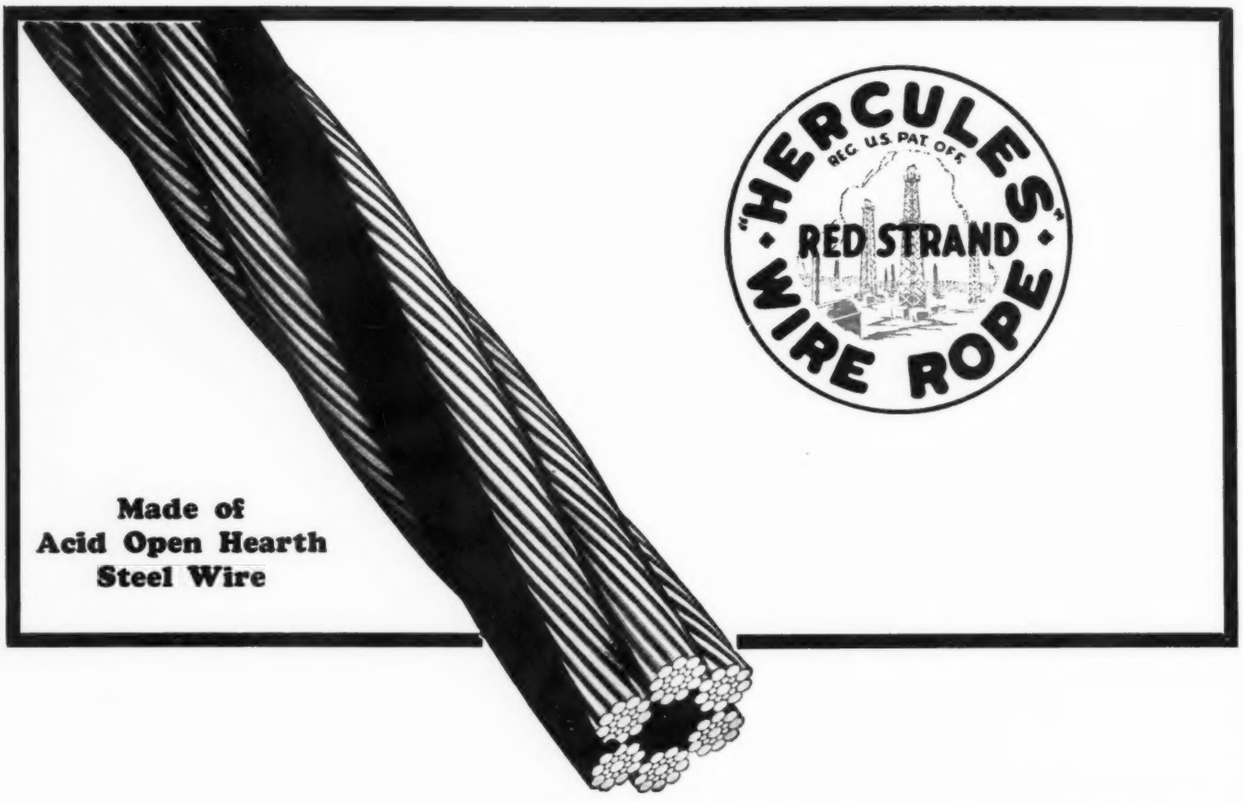

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The Course of Oil

By K. C. SCLATER

Accepted Without Question

Attempts to trespass underground on neighboring properties by unprincipled operators will have little chance hereafter of succeeding in California —or elsewhere for that matter. During a recent trial by jury in one such case, the details of which are the subject of an article in this issue, the evidence submitted palpably showed the defendants to be guilty. The defendant company, like several others, deliberately began drilling a well on a tract known to be unproductive of oil and whipstocked it into a neighboring property that was known to be productive of oil. Proof that the well was producing from a neighboring property belonging to another company was based on subsurface surveys, the results of which were submitted as evidence. There was no escape from this evidence; it was accepted without question as tangible and positive. The only remaining point at issue was whether the company had willfully controlled the direction of the well.

The fact that the subsurface surveys were so accepted by the court in proving malpractice is a tribute to those who have pioneered and brought to its present degree of refinement the art of well-surveying.

●

Revolutionary Practices Propounded

One of the most thought-provoking discussions ever to come from an engineer on possible petroleum development and production methods of the future was that presented by V. H. Wilhelm in New York last month at the annual meeting of the American Institute of Mining and Metallurgical Engineers.

All the advanced ideas put forth are based on the possibilities of oilfield development solely by controlled directional drilling methods. Some of the practices suggested are so revolutionary in scope as to border on the fantastic. One such is the installation in each field of a central power production plant in which a drum forty feet in diameter could be employed to wind the pump rods on when pulling wells.

Quite regardless of the practicability of this idea, the very fact of suggesting it in this instance appears to be incompatible, for the intrepid author propounds the most advanced ideas on development yet assumes no progress in the mechanical or other means employed in the hole by which wells might be produced. It is here pointed out that were this glaring inconsistency removed, it might also remove the need for the gigantic drum.

Some of the ideas suggested in this constructive paper may jolt petroleum engineers of the conservative type. It is a stimulating glimpse into the possibilities of the future.

Award for Engineering Achievement

Word comes from New York that the board of directors of the American Institute of Mining and Metallurgical Engineers has authorized the appointment of a committee to draw up rules of procedure under which awards can be made from time to time to petroleum engineers for outstanding contributions to the art of finding and producing oil and gas. These awards will be sponsored by the Petroleum Division of the American Institute of Mining and Metallurgical Engineers and will be in the form of either a gold medal, scholarship, or other suitable prize.

About fifteen years ago, shortly after his death, admirers of Captain Anthony F. Lucas started a fund to be used to establish a medal as an appropriate memorial in his honor. Through additional subscriptions, augmented by accrued interest, the principal will now yield sufficient income to finance awards at suitable intervals.

Captain Lucas was a pioneer in the oil industry, one of the early "wildcatters." As long ago as 1901, he became convinced that Spindle Top, a dome rising about twelve feet above the coastal prairie south of Beaumont, Texas, could be profitably exploited for oil. Most oil men at the time scoffed at the notion. But Captain Lucas went ahead and drilled. In January, 1901, he brought in a well that ran wild for ten days, yielding more than a hundred thousand barrels daily at the start. Later, Spindle Top became a great oil field and began a new era in the oil industry.

Captain Lucas is famous not only as the discoverer of Spindle Top but also as a capable mining and petroleum engineer. He became a member of A.I.M.E. in 1895, and for a number of years was a chairman of the Petroleum Committee of the Institute. This committee was the forerunner of the present Petroleum Division of the Institute, which is one of the most important branches of the Institute's activities.

John M. Lovejoy, chairman of the Lucas Memorial Fund Committee last year and president of the Institute for 1936, has named a special committee consisting of E. DeGolyer, chairman; W. B. Heroy, Henry Krumb, J. M. Lovejoy, H. N. Marsh, Wallace E. Pratt, and J. V. W. Reynders. This committee has been instructed by the board of directors to draw up a detailed plan for the establishment of the medal and any other prizes or awards that seem desirable. It is expected that a committee of award will be appointed in time to nominate a candidate for a medal to be presented in February, 1937.

Making an award for achievement in petroleum engineering is a worthy means of honoring the memory of a pioneer in the oil industry who also was a capable mining and petroleum engineer.

« « « HIGHLIGHTS IN OILDOM » » »

California Crude Prices Advanced

The long-awaited crude price advance in California has finally been realized in all but a few fields. The Standard Oil Company, effective February 26, announced advances ranging from 5 cents to 32 cents, depending upon gravity and type of crude. The advance went into effect in those fields where producers had reduced their daily production to the volume established by the new curtailment plan that had as its objective a daily output for the state of 537,000 barrels. The areas not receiving the increase were those that had failed to conform fully with the plan, and included Signal Hill, Alamitos Heights, Huntington Beach, Playa Del Rey, Dominguez, Santa Fe Springs, Kern Front, Elk Hills, and the Lakeview area of Midway-Sunset. A second announcement, effective March 7, advanced crude prices in the Playa Del Rey, Santa Fe Springs, Huntington Beach, and Signal Hill fields.

In making its first announcement the Standard Oil Company issued the following statement:

"In January of this year Standard Oil Company of California informed those from whom it buys crude oil that existing production of approximately 680,000 bbl. per day threatened the entire oil industry of this state with disaster. It was estimated that to balance supply and demand, leaving petroleum stocks on December 31, 1936, at the same figure as December 31, 1935, would require production of crude oil not in excess of 537,000 bbl. for each day of the year 1936. This figure contemplates additions to storage during the first and latter parts of the year with balancing withdrawals from storage during the intervening peak season.

"The company stated that if production were brought down to this daily average of 537,000 bbl. for the year, and such production equitably distributed between all fields, the company would increase the price it offers for the purchase of refinable crude oil to a base price of $1.10 per bbl. of 27-deg. gravity Signal Hill crude oil (an advance of 20 cents per bbl.) with differentials for other gravities according to usual practices, as well as an advance of at least five cents per bbl. in the price for heavy crude oil.

"Committees of the industry, in a coöperative effort, subsequently fixed relative figures of lower production for the various fields upon a basis which operators generally considered equitable. In most of the fields the lower production figure has been achieved. In others substantial progress has been made, and in a few but little has been accomplished.

"Because of the fact that so many operators already have met the lower production figure, and because it is believed that all fields shortly will be fully coöperating, and pending the efforts being made in those fields which have not met the lower production figure, the company will now make effective the higher prices indicated in its offer of January 18 in those fields where the lower production figure has been reached, as of 7 a. m., Wednesday, February 26, 1936. The offer of January 18 was conditioned upon the state's total production being an average of 537,000 bbl. daily for the entire year.

"In the fields where the lower production figure has not been reached prices will remain unchanged."

●

New Zoning Plan for Fitts

Members of the Oklahoma State Conservation Committee and of the various producing companies interested in the area have worked out a new zoning plan for the Fitts field of Pontotoc County, Oklahoma, applicable to Upper Simpson wells. The plan is as follows:

Zone 1: Sections 25, 26, 35, and 36 of 2n-6e, and sections 19, 30, and 31 of 2n-7e.

Zone 2: Section 20; the west ⅜ of 21; section 29; the west ⅜ of section 28; section 32; the west ⅜ of section 33, all in 2n-7e.

Zone 3: Section 22; the east ⅝ of section 21; section 27; the east ⅝ of section 28; section 34; the east ⅝ of section 33, all in section 2n-7e.

Bottom-hole pressures for the three zones are as follows:

Zone 1: The bottom-hole pressure as of February 2 was 1327.45 lb. as compared with 1300.10 lb. as of March 2, a decline of 27.35 pounds. Production in the zone was 723,747 bbl., making a decline per 1000 bbl. of .0377 pounds.

Zone 2: Bottom-hole pressure as of February 2 was 1465.72 lb., as compared with 1439.00 lb. for March 2, a decline of 26.72 pounds. Total production for the zone was 335,255 bbl., a decline per 1000 bbl. of .0797 pounds.

Zone 3: This is a newly-formed zone so no comparative figures are available. Production for the zone as of March 2 was 127,642 bbl., with the bottom-hole pressure 1642.6 pounds.

●

Must File Results Potential Tests Within Five Days

Results of potential tests, required by the railroad commission for each newly-completed well in Texas, must be filed with the commission's office within five days after the test is made, according to an order effective March 1st. The order also provides that allowables based on these potential tests will not be retroactive for a period longer than five days prior to the date the potential test form is received. This latter is for the purpose of assuring coöperation in the enforcement of the order.

Potential tests shall be made on all wells shot or treated with acid, the order also provides, and allowables will be based on these tests for the 60 days after they are made. During the latter 20 days of this 60-day period, however, new tests must be made upon which to base future allowables.

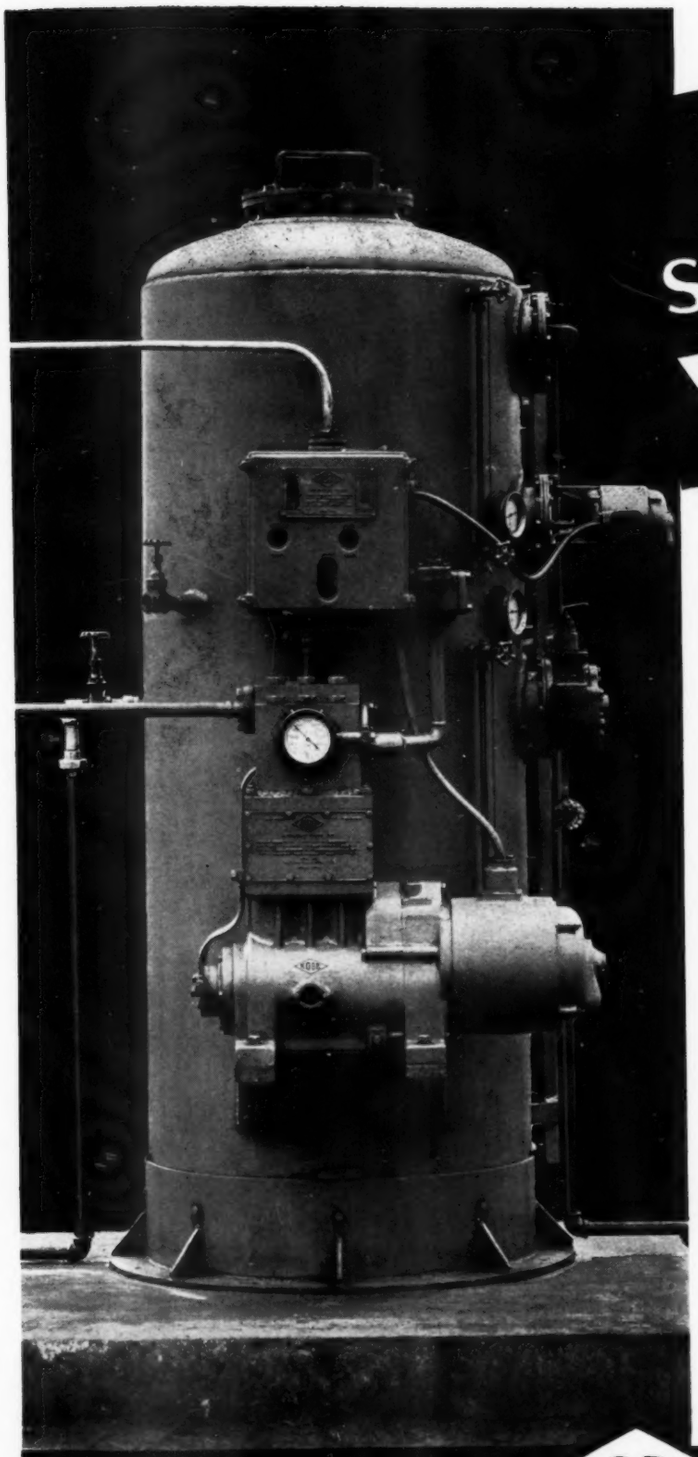
●

New Potentials For O. C. Wells

According to the Oklahoma Oil and Gas Conservation Department, the first group of 13 Wilcox zone wells in the Oklahoma City field to take new potential tests early in March showed a combined daily potential of 23,270 bbl., compared with 29,413 bbl. last October, an average decline of 20.89 percent.

The Carter Oil Company's No. 2 Wepaco showed the greatest decline, dropping from 1592 bbl. to 425 bbl., a decline of 73.3 percent. The second greatest decline was the Indian Territory Illuminating Oil Company's No. 3 Wisel, which dropped from 1814 bbl. to 613 bbl., or 66.2 percent. Two other wells declined more than 50 percent: Carter Oil Company's No. 1 Wepaco, from 817 bbl. to 347 bbl., and the I.T.I.O.'s No. 1 Spannagel, which dropped from 700 bbl. to 327 barrels.

Five wells showed gains, however, reducing the percentage of decline for the entire group. The Phillips Petroleum Company's No. 1 Reserve advanced from 2459 bbl. to 2806 bbl., up 14.1 percent; Skelly Oil Company's No. 1 Harper-Turner gained from 630 bbl. to 709 bbl., up 12.5 percent; the Burns No. 1 Potts from 4173 bbl. to 4628 bbl., up 10.9 percent; the I.T.I.O. No. 3 Lawrence Place from 633 bbl. to 656 bbl., a gain of 3.6 percent; and Jameson-Grimes' No. 1 Grimes from 2552 bbl. to 2615 bbl., an increase of 2.5 percent.



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PROGRESS OF MAJOR PIPE LINE WORK

THE 8-in. line being laid by the American Liberty Pipe Line Company from Rusk, Texas, to Conroe, a distance of 107 miles, is progressing in a satisfactory manner and is expected to be completed and tested by April 10. That date is later than was first predicted, but unfavorable weather since the first of the year has delayed construction work somewhat. When finished this will give the American Liberty a continuous outlet from the East Texas field to the Gulf Coast, since that company already is the owner of a pipe line system from Conroe to Houston, and recently purchased the Liberty Pipe Line Company's line from the East Texas field to Rusk.

Four new pumping stations are being constructed. At Oakhurst, Pennington, and Rusk the pumping units will be Diesel powered, while at Summerfield they will be electrically driven. Equipment in the former stations will consist of two 320-hp. Diesel engines driving 6-stage centrifugal pumps, operating in series. The electric station will have two 250-hp. motors driving 6-stage centrifugal pumps.

The rated capacity of the line will be from 30,000 bbl. to 35,000 bbl. per day, and it is expected that initially approximately 30,000 bbl. will be handled.

Dudley S. Golding is president of the American Liberty Pipe Line Company, Clint W. Murchison and T. L. Wynne are vice-presidents, and D. R. Zachry is secretary and treasurer. Headquarters are in Dallas.

●

Construction work is well underway on the 54-mile 8-in. pipe line being laid from the Rodessa field of Louisiana to East Texas field by the East Texas Oil and Refining Company of which Freeman Burford, Dallas, is president. From 35 to 40 miles of pipe already have been laid and it is expected that the entire project will be completed by the latter part of the month. The line is being welded by the Lindeweld method, using the multi-flame welding head. Williams Brothers, Tulsa, Oklahoma, are the contractors. One pumping station will be erected, that in the Rodessa field.

●

Plans for the construction of a 10-in. welded pipe line from the Hugoton, Kansas, gas field to northwestern Kansas and southwestern Nebraska, a distance of 378 miles, were announced recently by L. H. Meyers, of Dodge City, Kansas, oil operator, who is representing a Boston banking and investment firm. Construction will start, Meyers said, as soon as franchises for gas distribution have been arranged in towns that the company proposes to serve.

●

The Kansas Corporation Commission has approved an application of the Kaw Pipe Line Company to extend its line to serve the Ruder and Victoria pools in Ellis County, Kansas. The Kaw recently completed its line into western Kansas, serving approximately 35 pools. The Ruder pool has five wells and the Victoria pool one, with a number of drilling operations in progress.

One section of the Crude Oil Pipe Line Company's line from the Government Wells area of Duval County, Texas, to Corpus Christi has been completed. Crude is being pumped through the 25-mile section from the Loma Novia field to San Diego where it is being loaded into tank cars for transportation to Corpus Christi. The remaining 50 miles of the line, from San Diego to Corpus Christi, will be completed by April 1 if present plans are fulfilled.

This is a 5½-in. line and will have a daily capacity of 10,000 barrels. A Diesel-powered pumping station has been erected in Duval County, while at San Diego a second station has been constructed in addition to storage facilities and loading racks.

At Corpus Christi a terminal will be constructed near the ship channel.

N. A. Saigh Construction Company, San Antonio, Texas, has the general contract for the laying of the line.

●

Officials of the Atlantic Pipe Line Company, Dallas, Texas, have announced that they will construct a 60-mile 8-in. line from the Rodessa field of Louisiana to the company's Horton station on the east edge of the East Texas field in southern Gregg County. J. H. Wood, general manager of the Atlantic, says the line will be completed by May 1st.

In the Rodessa field three 55,000-bbl. storage tanks will be erected, and a gathering system will be constructed.

●

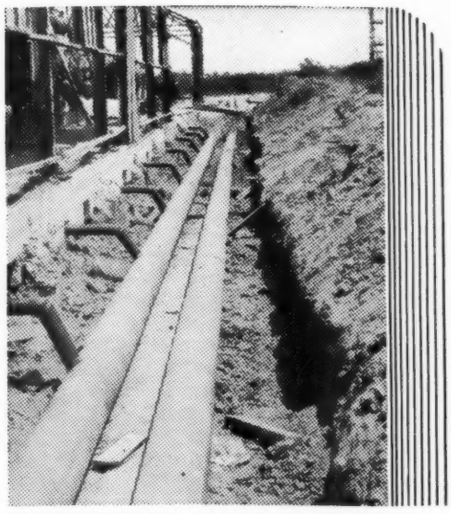
Application has been made to the Wyoming Public Utilities Commission by the Illinois Pipe Line Company for a permit to lay an oil line from Lusk to Fort Laramie, Wyoming, a distance of 40 miles, providing an outlet for Lance Creek crude. The line would tie into the Stanolind Pipe Line Company's system at Fort Laramie. Preliminary plans call for an 8-in. line with a booster station south of Lusk.

●

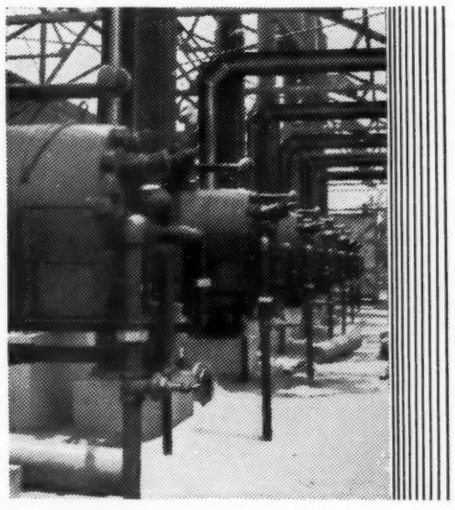
Officials of the Northern Natural Gas Company have announced that construction will start within a few weeks on a 100-mile 20-in. welded line from the Hugoton gas field of Kansas to Mullinville. The A. O. Smith Corporation will supply the pipe, it is stated.

●

Between Burrton and Valley Center, Kansas, the White Eagle Division of the Socony-Vacuum Oil Company is to increase the capacity of its pipe line from 12,000 bbl. daily to 20,000 barrels. From 25 to 30 miles of 8-in. loops will be laid.



This Lindewelded pipe can be buried and forgotten



Lindewelding also can be done on vertical and overhead lines

The Multi-Flame Lindeweld Head in action

80-MILE PIPING SYSTEM FOR GASOLINE PLANT *Lindewelded**

● The construction of an East Texas gasoline plant required approximately 80 miles of welded pipe. The piping system included gathering lines from over 1000 wells. It involved straight line runs, headers, bull-plugs, bends, angles and other specials. Pipe size ranged from 3-in. to 26-in. diameter — 5/32-in. to 7/16-in. wall.

The Lindeweld method of oxy-acetylene welding was selected for this project after competitive tests with other types of pipe joints. The company found Lindewelding produced dependably uniform results, cost less, and could be done in less time.

The entire system was tested under pressure. Many of the welding operators had not used Lindewelding previously. Yet the company's engineers reported they did not find a single defective weld.

Lindewelding was brought to this project as a part of Linde Process Service, which is regularly available to Linde Customers — without charge. Linde Offices will gladly give you complete details on Lindewelding. They are located in Atlanta — Baltimore, Birmingham, Boston, Buffalo, Butte — Chicago, Cleveland — Dallas, Denver, Detroit — El Paso — Houston — Indianapolis — Kansas City — Los Angeles — Memphis, Milwaukee, Minneapolis — New Orleans, New York — Philadelphia, Phoenix, Pittsburgh, Portland, Ore. — St. Louis, Salt Lake City, San Francisco, Seattle, Spokane and Tulsa. The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation.

*** Lindewelding is a new method of oxy-acetylene welding developed by the Linde engineering and research organizations. This method requires less oxygen, less acetylene and less welding rod. Welds can be completed in less time. Yet Lindewelding involves only a special flame adjustment and a "back-hand" technique, together with Oxweld No. 24 Lindeweld Process Welding Rod. When circumstances permit, the Multi-Flame Lindeweld Head can be used. This will further increase the speed of Lindewelding. It costs only $7.75. On pipe line construction Lindewelding is consistently saving 15 to 40 per cent in welding time, rods and gases.**

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LATEST ACTIVITIES IN THE OIL FIELDS

ALTHOUGH the final production test has not yet been made in Housh & Thompson, Inc., and R. L. Peveto, et al, well No. 1 Carr in the Talco area of Titus County, Texas, the initial showing of this wildcat has given rise to a major lease play in the area and resulted in the commencing of several drilling operations. Drilling of the plug in No. 1 Carr is awaiting the equitable settlement of certain legal matters.

A 25-minute drill stem test, made at a depth of 4166-4208 ft. had an excellent showing, the hole filling 750 ft. with oil. Production is from the Paluxy sand of the upper Trinity.

●

A new deep field has been opened on the Gulf Coast of Texas by the Hamman Exploration Company, one and one-half miles southeast of Bay City, Matagorda County. That company's No. 1 Mary Cleveland was brought in making 25 bbl. of 35-gravity oil per hour. The well was drilled to a total depth of 9439 ft. and is producing from the Frio formation.

●

In the Jeanerette field of St. Mary Parish, Louisiana, a new producing sand has been discovered by the Herton Oil Company, who completed their well, No. 2 Roane, at a total depth of 6665 feet. The well flowed 1098 bbl. daily through a 5/16-in. choke on the initial production test. Both the tubing pressure and the casing pressure were 1000 pounds. Oil tested 36.7 gravity.

●

With the successful completion of its No. 1 Hobson the Continental Oil Company has opened a new field in Ventura County, California, to be known as the Javon field. It is situated two miles east of the Rincon field. Completed at a total depth of 5501 ft., the well produced 478 bbl. of 30.1-gravity oil per day, cut 2.7 percent, through a 32/64-in. bean.

Most of the acreage in the area is held by the Continental Oil Company, Chanslor-Canfield Midway Oil Company, and the General Petroleum Corporation.

●

Considered by many as one of the most important Oklahoma discoveries since the Fitts pool was brought in, the Phillips Petroleum Company and the Shell Petroleum Corporation have completed a Wilcox sand well in the old Billings pool of northwestern Noble County. The well, No. 1-A McCaughtry, flowed 687 bbl. of crude in 28 minutes, as well as gas at the rate of 29,500,000 cu. ft. per day. Total depth of the well is 4258 feet.

●

Barton County, Kansas, has been given a new pool near Clafin in the northeastern part of the county by Yarnell and Carlson's No. 1 Bloomer. After being acidized the well produced 470 bbl. daily on the initial test. Production is from the Arbuckle lime at a total depth of 3257 feet.

●

A drill stem test on James and Associates No. 2 Vesser in the East Rainbow field of Union County, Arkansas, yielded more than 10,000,000 cu. ft. of gas and considerable oil at 3257 feet. This is approximately 80 ft. below the Sullivant sand and more than 100 ft. above the original Rainbow pay, and for that reason it is believed a new producing sand has been uncovered in the field. Should this prove to be the case it will open the seventh level for the Rainbow field.

●

California is witnessing the drilling of three important tests of the deep Eocene sands. No. 12 Bell of the Barnsdall Oil Company and the Rio Grande Oil Company near Santa Barbara in the Elwood field is below 7000 feet. In the North Belridge field of Kern County the Union Oil Company has its No. 7 Gibson below 9000 feet. The Union Oil Company drilled its No. 1 Lillis-Welch to 11,147 ft. and plugged back to 10,760 feet. The results of these three tests are expected to determine the production possibilities of the Eocene sands.

AVERAGE CRUDE PRICES

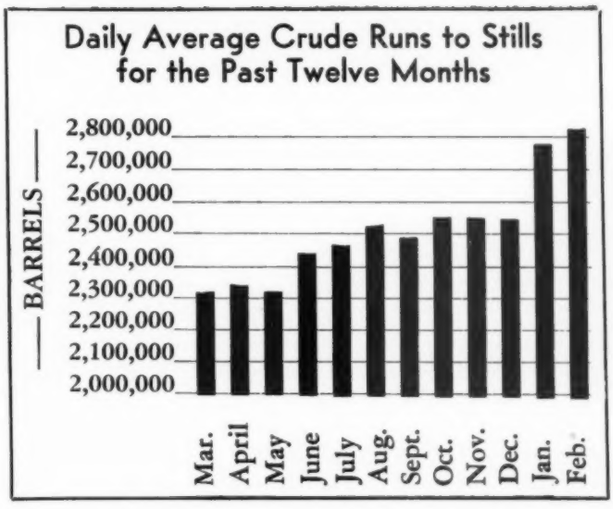
California	
Kettleman Hills	$1.22-$1.43
Playa Del Rey	1.10
Coalinga	.70-.90
Signal Hill	1.10
Montana	1.45
Wyoming	1.10
Colorado	1.00-1.10
New Mexico	.75-.95
Texas	
North Central	.84-1.08
Panhandle	.81-.98
West Texas	.75-.95
Gulf Coast	.85-1.30
Darst Creek	.88-1.22
East Texas	1.15
Kansas	1.10
Oklahoma	1.10
Arkansas	.75-.80
Louisiana	
North Louisiana	$ .86-$1.10
Gulf Coast	.82-1.22
Illinois	1.23
Kentucky	1.23
Indiana	1.12
Ohio	
Lima	1.25
Michigan	1.12
Pennsylvania	
Bradford	2.45
Southwest	2.17
Eureka	2.12
Buckeye	1.97
Corning	1.42
West Virginia	1.67
Canada	2.10-2.17

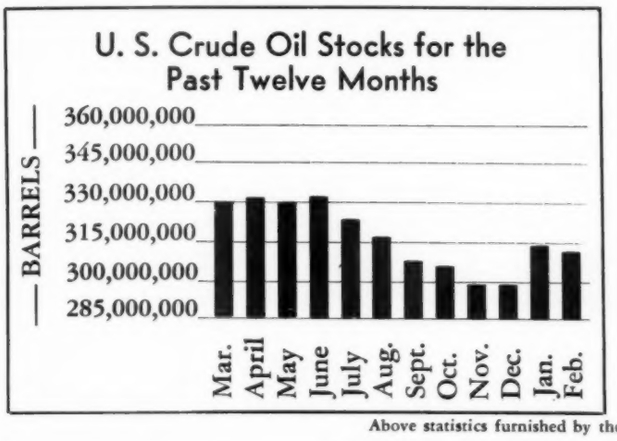
DAILY AVERAGE CRUDE OIL PRODUCTION

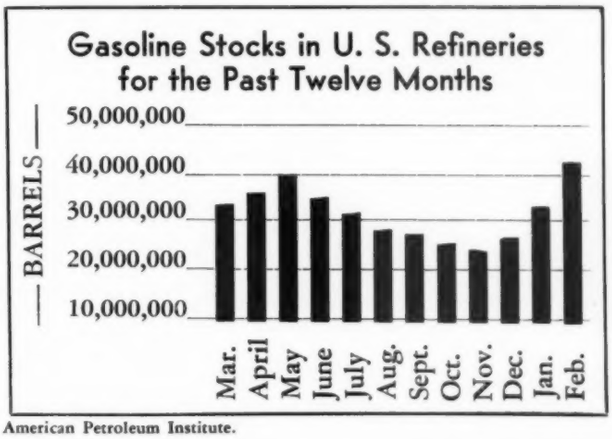
Furnished by A.P.I.

(Figures in Barrels)

	B. of M. Dept. of Interior Calculations (February)	Week Ended Feb. 29, 1936	Week Ended Feb. 1, 1936	Week Ended Mar. 2, 1935
Oklahoma	483,700	499,500	497,250	457,800
Kansas	137,400	149,650	137,200	146,400
Panhandle Texas		60,450	59,650	62,850
North Texas		56,600	56,550	57,550
West Central Texas		24,800	25,350	25,650
West Texas		162,200	147,900	150,300
East Central Texas		48,600	44,250	51,250
East Texas		436,600	433,300	438,300
Southwest Texas		70,750	68,800	59,900
Coastal Texas		220,150	205,650	177,050
TOTAL TEXAS	1,068,200	1,080,150	1,041,450	1,022,850
North Louisiana		66,200	57,350	23,000
Coastal Louisiana		133,750	131,300	94,400
TOTAL LOUISIANA	141,100	199,950	188,650	117,400
Arkansas	29,900	29,550	30,200	30,050
Eastern	102,000	107,950	96,300	106,550
Michigan	44,800	37,300	40,200	33,350
Wyoming	34,400	32,150	33,750	31,400
Montana	11,900	12,400	13,750	10,800
Colorado	3,800	4,000	3,900	4,300
New Mexico	61,300	57,100	58,000	47,250
TOTAL EAST OF CALIF.	2,118,500	2,209,700	2,140,650	2,008,150
California	529,600	565,000	674,900	465,700
TOTAL U. S.	2,648,100	2,774,700	2,815,550	2,473,850







Above statistics furnished by the American Petroleum Institute.

Summarized Operations in Active Fields for February, 1936

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas								
East Texas	195	187	85	138	3600	2	40	Rotary
Duval County	85	73	15	30	2300	2	22	Rotary
Archer County	34	20	12	29	660–1800	1 or 2	40	Rot.-Cab.
Conroe	2	1	1	1	2000–7400	3 or 4	40	Rotary
Panhandle	48	46	29	142	2200–3900	2	40	Rotary
Refugio County	5	3	2	3	5200	2	38	Rotary
Oklahoma								
Oklahoma City	6	2	4	36	6500	3	39	Rotary
Pontotoc County	29	25	13	84	1800–4488	2 or 3	38	Rotary
Osage County	22	19	14	40	380–2850	2	37.5–40	Rot.-Cab.
Kansas								
McPherson County	2	2	2	5	2900–4300	2	38	Rot.-Cab.
Harvey County	4	2	2	3	3450	2 or 4	37	Rot.-Cab.
Ellsworth	43	32	31	116	3300	4	37	Rot.-Cab.
California								
Kettleman Hills	3	3	4	31	8300	3 or 4	40	Rotary
Long Beach	3	2	2	15	7000	3	36	Rotary

Field Activities by States for February, 1936

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1935 (In Barrels)
	February	January	February	January	February	January	February	January	February	January	
Arkansas	4	10	3	3	5	8	11	11	31	32	11,140,750
California	62	87	53	50	67	40	84	65	203	209	207,899,480
Colorado	....	....	....	....	....	....	4	1	26	25	1,565,150
Illinois	2	2	1	2	....	....	21	25	5	1	4,352,000
Indiana	9	24	3	8	....	....	2	3	61	53	762,000
Kansas	83	123	58	91	121	117	49	45	267	147	53,013,450
Kentucky	21	....	11	....	....	....	3	11	13	14	4,860,000
Louisiana	55	62	45	39	98	71	52	28	175	139	50,299,950
Michigan	35	79	24	54	39	56	80	81	117	84	15,661,350
Mississippi	1	....	0	....	....	....	1	1	10	9	Gas. Prod.
Montana	6	10	5	9	....	....	10	7	55	45	4,304,100
New Mexico	40	28	37	27	....	....	12	10	107	97	19,195,500
New York	....	....	....	....	....	....	2	3	3	2	3,191,900
Ohio	229	164	179	117	....	....	33	35	161	149	4,234,000
Oklahoma	162	260	129	185	184	192	64	47	527	407	181,152,050
Pennsylvania	....	....	....	....	....	....	13	18	108	86	14,478,000
Texas	757	943	596	739	1104	754	452	270	1262	802	377,747,205
West Virginia	52	67	42	49	....	....	30	17	113	98	3,818,400
Wyoming	2	4	2	3	....	....	8	6	61	54	13,320,100
Totals	1518	1863	1187	1375	1618	1238	910	671	3300	2464	970,995,385

THE MONTH'S ACTIVITIES IN REFINING

Percent Refinery Capacity Operated

Western Division, 65.5 percent **Central Division, 70.3** **Eastern Division, 79.3 percent**

THE East Texas Refining Company is doubling the capacity of its plant at Longview, Texas. The present capacity is 10,000 bbl. daily. The enlargement program is scheduled to be completed about April 1st. The plant will be served by the new 8-in. pipe line being laid from the Rodessa field of Louisiana, in addition to the existing East Texas field connections.

●

The Independent Refining Company of Billings, Montana, has signed a license agreement with the Universal Oil Products Company and has contracted with The Ralph M. Parsons Company to remodel its refinery to operate the Dubbs cracking process. A reaction chamber, a flash chamber, and a fractionating tower, together with absorber and stabilizer, as well as a vacuum distillation unit for the production of asphalt direct from the cracking unit or the crude still, are being installed. The pump and control house is being completely redesigned and reconstructed to centralize the control functions in a compact and comfortable room. Eventually a heavy-oil furnace will be built to make possible full two-coil, selective Dubbscracking, it is announced.

●

The Ewmo Refining Company, Fort Worth, Texas, is installing new towers, a modern cracking still, and a preheater at its 1000-bbl. skimming plant at Hawley, Jones County, Texas.

●

The Producers Refining Company, Inc., will erect a $250,000 refinery at West Branch, Michigan, it has been announced. The Roy J. Miller Petroleum Engineering Company of Chicago has been awarded the contract for the construction work.

Carl J. Westlund is president and E. L. Dalton vice-president and treasurer of the former company.

●

The Barnsdall Refining Corporation is completing plans for the installation of a 6000-bbl. combination cracking and topping unit at its Barnsdall, Oklahoma, refinery. Construction work is expected to commence shortly.

C. A. Middleton, Corsicana, Texas, is erecting a 1000-bbl. skimming plant at Baldridge siding, seven miles southeast of the Masterson pool in Pecos County, Texas. The finished gasoline will be shipped by tank car.

●

The Valvoline Oil Company's refinery at Warren, Pennsylvania, closed down for several years, will be reopened, information emanating from headquarters of the company indicates. The plant has a daily capacity of 1000 bbl. and is equipped for the manufacture of lubricants, waxes, and petrolatums.

●

Early in the month the Pure Oil Company announced that from $1,500,000 to $2,000,000 would be expended to increase the capacity of its refinery at Smiths Bluff, near Beaumont, Texas. The Lummus Company of New York City has been awarded the contract for the addition of units that will boost the capacity of the plant from 30,000 bbl. daily to 50,000 barrels.

●

New installations of Gray process clay treating plants affecting a combined gasoline refining capacity of approximately 24,000 bbl. per day are reported by Dr. M. R. Mandelbaum, vice-president of The Clay Processes Corporation, New York. Gulf Oil Corporation of Pennsylvania has taken a license for clay treating a substantial part of its cracked gasoline production. It is expected that the first unit to be constructed under this license will be in operation this spring.

Other Gray process units are being installed by the Atlantic Refining Company at its new Atreco, Texas, refinery, where clay treating will be used to refine both cracked and polymerized gasoline, and also by Pan American Petroleum and Transport Company in connection with its new combination cracking unit at Texas City.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending February 29, 1936
A.P.I. Figures
(Figures in Barrels of 42 Gallons Each)

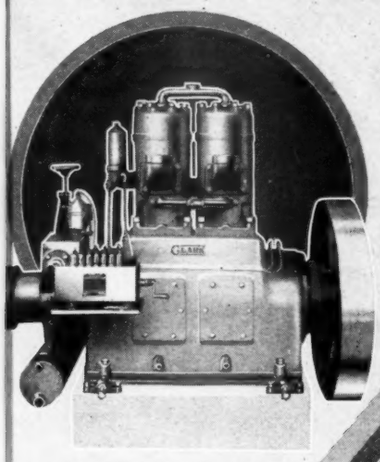
DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	515,000	84.2	17,055	5,859
Appalachian	94.8	94,000	64.4	2,873	693
Ind., Ill., Ky	95.9	379,000	89.4	11,129	2,343
Okla., Kans., Mo.	84.8	256,000	66.7	7,967	2,637
Inland Texas	48.5	88,000	55.0	1,826	1,345
Texas Gulf	96.8	621,000	94.4	9,392	8,049
La. Gulf	96.4	135,000	82.8	1,728	2,530
No. La.-Ark.	90.0	38,000	52.8	401	429
Rocky Mt.	61.9	40,000	66.7	1,517	702
California	92.6	508,000	64.4	13,384	70,011
Reported	89.6	2,674,000	77.1	67,272	94,598
Est. Unreported	.....	196,000	.....	4,312	1,258
*EST. TOTAL U. S. Feb. 29, '36	.....	2,870,000	.....	71,584	95,856
*EST. TOTAL U. S. Feb. 22, '36	.....	2,850,000	.....	69,353	96,586
U. S. B. of M. February, '35	.....	2,529,000	.....	**64,888	**101,085

*Bureau of Mines basis currently estimated.
**As of February 28, 1935. On March 31, 1935, total stocks of finished and unfinished gasoline were 66,290,000 barrels.

CLARK "Bobcat"

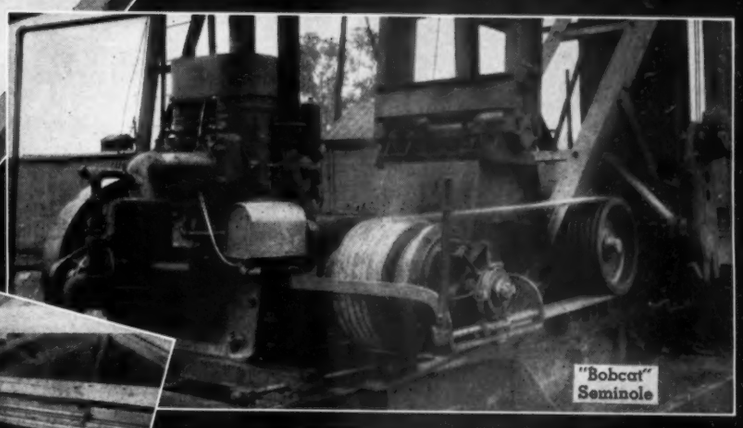
THE PIONEER VERTICAL PUMPING ENGINE

PAST THE EXPERIMENTAL STAGE



CLARK "Bobcat"
40 H.P. 2-Cycle
Roller-Bearing
Pumping Engine

For details
see 1936
Composite
Catalog

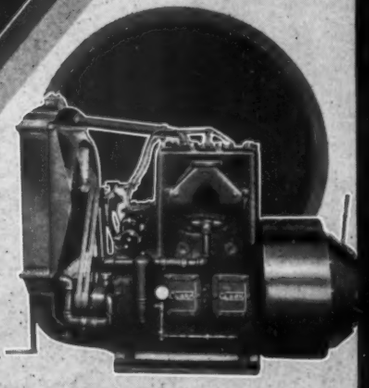


"Bobcat"
Seminole

"Bobcat"
Oklahoma City

"Bobkitten"
Oklahoma City

CLARK "Bobkitten"
20-30 H.P. 2-Cycle
Roller-Bearing
Pumping Engine



"Bobkitten"
East Texas

"Bobcat"
Oklahoma City

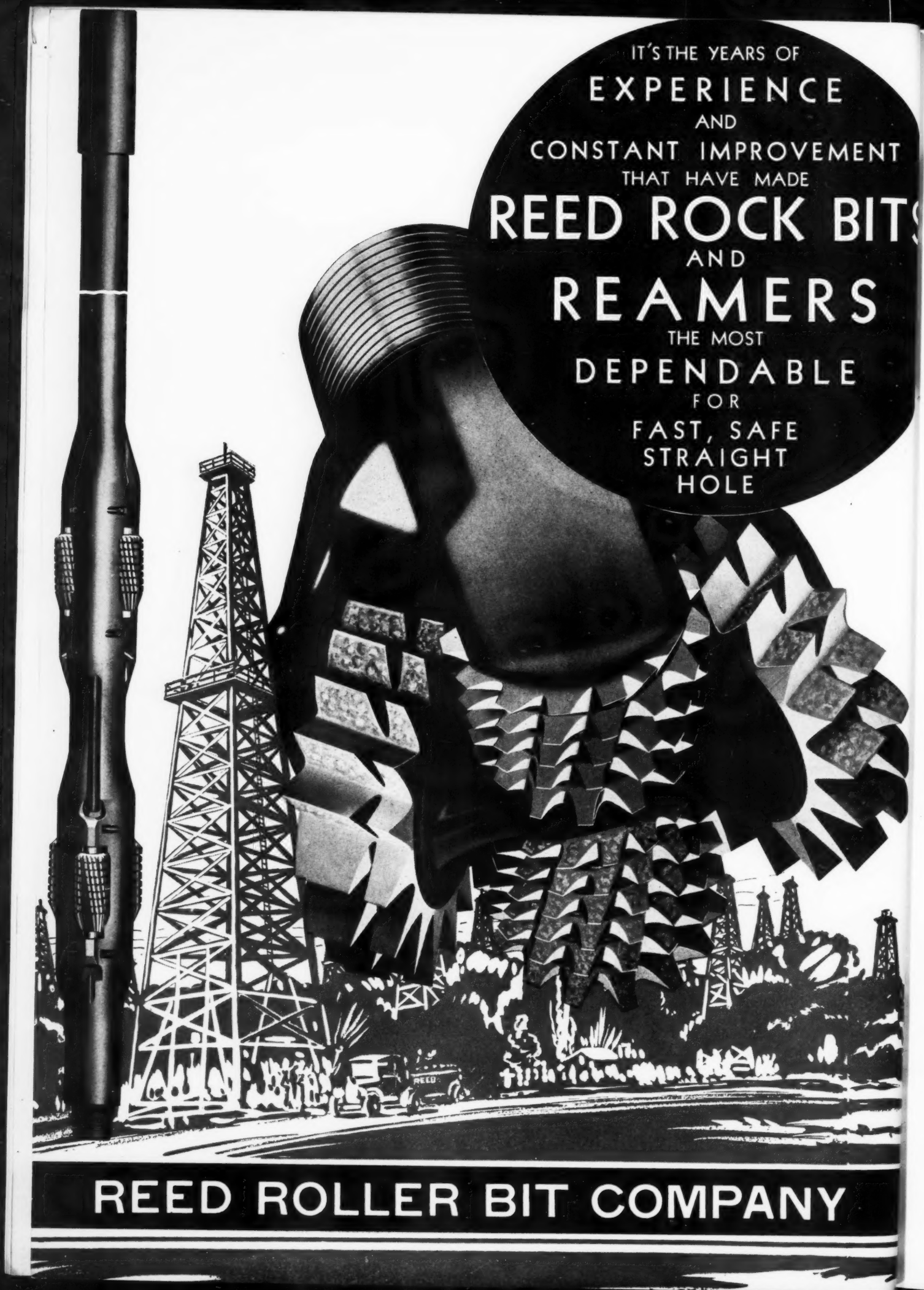
"Bobcat"
Oklahoma City

2 YEARS OF FIELD SERVICE

CLARK

CLARK BROS. COMPANY, OLEAN, NEW YORK, U. S. A.

Export Office: 30 Rockefeller Plaza, New York. Midcontinent Sales Offices and Warehouses: Tulsa, Okla., Dallas and Tyler, Tex. West Coast Office: Smith-Booth-Usher, 2001 Santa Fe Av., Los Angeles. Foreign Offices: 72 Turnmill St., E. C. 1, London, England. 4 Str. General Poetas, Bucharest, Roumania.


IT'S THE YEARS OF
EXPERIENCE
AND
CONSTANT IMPROVEMENT
THAT HAVE MADE
REED ROCK BITS
AND
REAMERS
THE MOST
DEPENDABLE
FOR
FAST, SAFE
STRAIGHT
HOLE
REED ROLLER BIT COMPANY

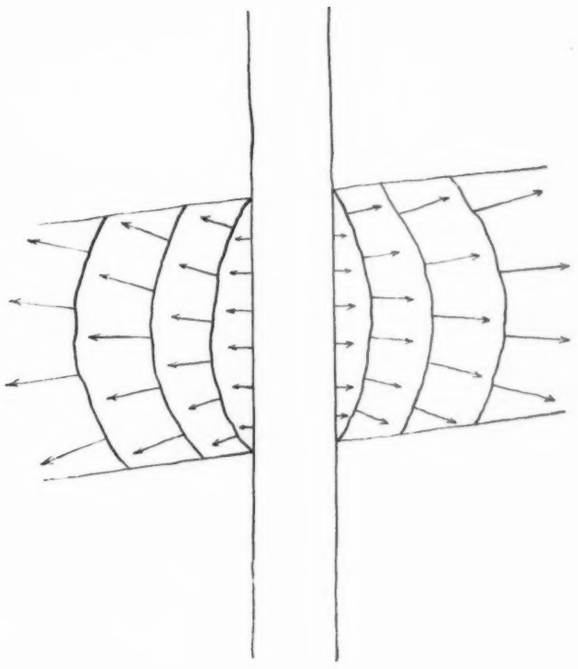


Fig. 1. Sketch illustrating infiltration of water (shown by arrows) into bed of shale exposed in hole and causing incipient caving, eventually leading to mass movement or "heaving" of the shale

Drilling Heaving Shale

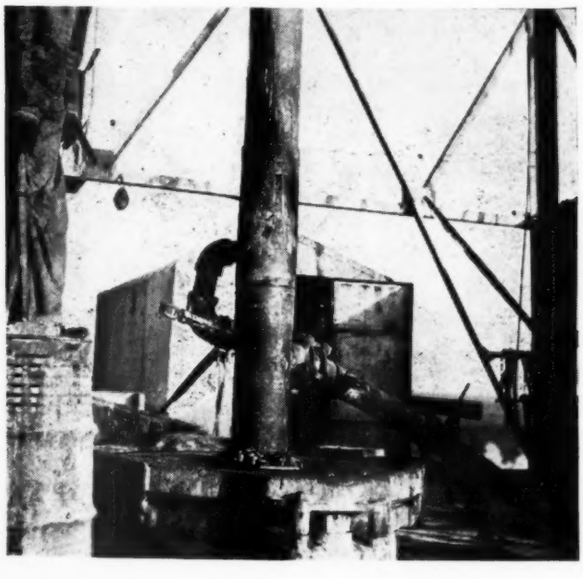
Some of the chemical and mechanical aspects of the difficulties involved and the methods used by one company to overcome them

By K. C. SCLATER

ABOUT two years ago the Continental Oil Company first came up against the heaving shale problem. This was in its drilling operations in Calhoun county, South Texas, and led the company to undertake a systematic study of the problem.

One of the first points of attack was a thorough investigation of the shales themselves, particularly with respect to their chemical characteristics and their behaviour in the hole during the course of drilling. This investigation has been carried on assiduously since May of last year by R. Van A. Mills, production research engineer of the Continental Oil Company.

His investigations disclose that innumerable varieties of shale are encountered that cause trouble in drilling. Most of the shales that heave have a tremendous affinity for water; when they take up water they swell and disintegrate. Shales that are subject to hydration are largely bentonitic in character. "The name bentonite has been applied to a group or series of clay-like materials characterized by an alkaline oxide and alkaline earth content of five to ten percent, fine grain size, high absorptive powers, and usually very strong colloidal properties."[1]



It is the bentonitic character of shales that accounts for their inordinate tendency to heave. "Bentonite is highly absorbent; when wetted it will absorb more than three times its weight or seven times its volume of water. Some varieties when wetted with water expand to more than six times (some experimenters report eight times) their original volume."[1]

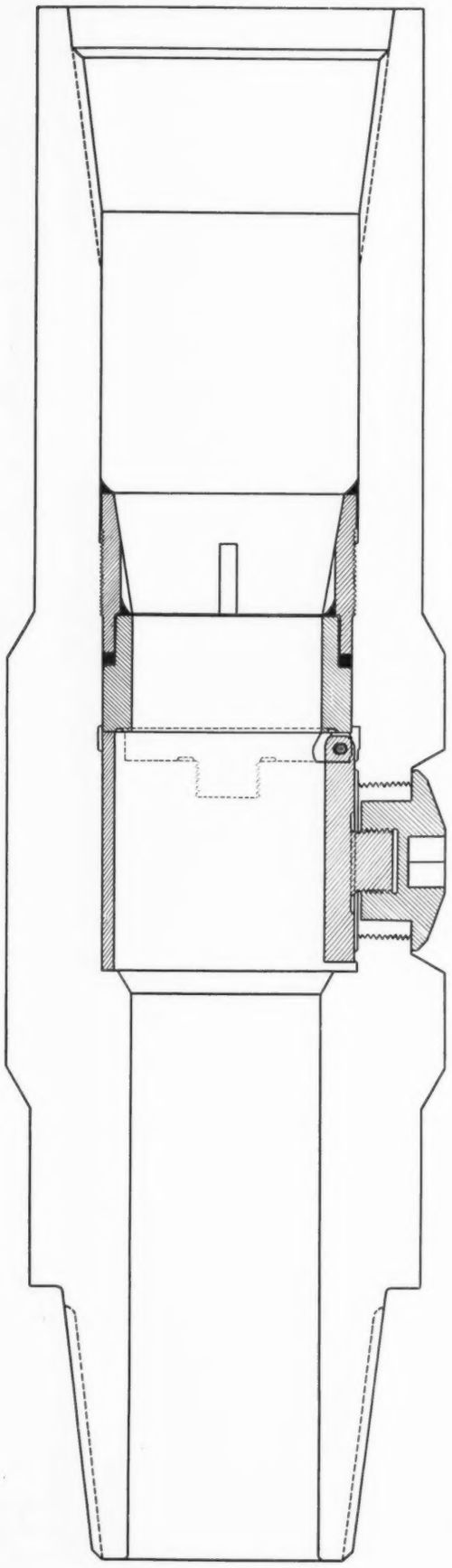
The term "heaving" as applied to a shale refers to the magnitude of the movement of that shale into the hole. Caving is much less severe than heaving and might be considered as heaving in its incipient stage. When a shale of the bentonitic type is penetrated by the drill and is wetted with water it begins to slough off or cave into the hole. Each time caving occurs fresh surfaces of shale are exposed and results in further caving (See Fig. 1). The caving gradually increases and eventually reaches the proportions of mass movement or heaving. This mass movement increases in magnitude with each successive "heave." A characteristic of this mass movement is that it seems to be self-propagating and once started is difficult or almost impossible to stop. Observations show that from the time the surface of the shale in the hole is first exposed to water, it usually takes from two to three days for heaving to develop.

All evidence gathered in the field and the laboratory indicated that a successful solution of the problem lay in finding some means of protecting the shale from being wetted by water, thereby preventing heaving from reaching even the incipient stage known as caving.

To meet this problem of preventing the shale from being

[1] "Bentonite" by Raymond B. Ladoo—U. S. Bureau of Mines Report of Investigations No. 2289.

Fig. 2. Mud hose connected to special joint, permitting continuous circulation while adding stand of drill casing—man standing on barrel is ready to knock wedges out of "hammer" joint above



wetted with water, R. Van A. Mills has developed a drilling mud, the chief ingredient of which is sodium silicate, or what is commonly known as water glass, the other ingredients being bentonitic mud and common salt (sodium chloride).

A simple explanation of one action of the sodium silicate is that it forms over the shale a gelatinous film that excludes water. There are also chemical reactions that take place.[2] Its chemical properties are also desirable in conjunction with alkali muds for shutting off water in oil and gas wells.[3]

A strongly alkaline brand of sodium silicate solution is used. The colloids formed by the bentonitic material stay in suspension in the highly alkaline solutions employed in the drilling fluid. It is not within the compass of this paper to discuss the chemical reactions involved other than to state that the sodium silicate reacts with the calcium, magnesium, and aluminum in the shale. In this connection attention is called to the chemical properties of bentonite: "Some, and perhaps all, of the minerals of the bentonite group have the property of allowing easy replacement of the alkaline and earth oxides, one with another. . . . if hard water containing calcium sulphate be passed through a mass of bentonite containing sodium, the calcium sulphate is changed to sodium sulphate (soluble) and the sodium in the bentonite is replaced by calcium. The process is reversible and the bentonite may be rejuvenated by passing through it a solution of sodium chloride. The sodium is restored to the bentonite and the calcium is removed as a chloride. It is probable that carbonates are removable in the same way. This easy replacability of the alkaline oxides may have an important bearing upon the physical properties of the bentonites."[1]

It may be gathered from this discussion of bentonite and its chemical properties that the proper type of mud fluid for the drilling well will depend on the chemical properties the shales encountered exhibit.

Various concentrations of sodium silicate are employed. They range from 30 to 60 percent, the concentration used being dependent on (1) the character of the shale being drilled and (2) the colloidal material in the mud; these are the two controlling factors governing the concentration. Higher concentrations than that stated have not been found necessary.

With reference to the mechanical phase of the problem, probably the dominant factor contributing to and aggravating a heaving-shale condition is the swabbing action of the wall of the hole when the drill pipe is pulled. This frequently causes a reduction of pressure sufficient to destroy the mud-sheath built up on the wall of the hole and cause caving. The frequent stoppages of circulation made necessary in pulling and running drill pipe also introduces a serious hazard if high-pressure gas is encountered. Gas-cutting of the mud increases this hazard.

In order to drill successfully a thick body of shale with heaving tendencies, it apparently was determined by officials of the Continental Oil Company that the chief mechanical requirements to be met during drilling through the shale, are: 1. The elimination of pulling of the drill pipe. 2. The maintenance of continuous circulation. 3. The drilling bit to be kept on bottom and rotation maintained continuously except when changing bits and adding drill stem.

Elimination of pulling of the drill pipe was made possible by employing wire-line (collapsible type) drilling bits, and flush-joint casing and stream-lined casing instead of drill pipe.

Continuous circulation was maintained by using special full-hole continuous circulation tool joints (see Figs. 2 and 3), and the time required to add a stand of drill casing was reduced by means of a special quick-

[2] "Protection of Oil and Gas Field Equipment Against Corrosion" by R. Van A. Mills—U. S. Bureau of Mines Bulletin 233, p. 77.

[3] "A Process of Excluding Water from Oil and Gas Wells." For public use under act of March 3, 1883—By R. Van A. Mills, U. S. Patent 1,421,706, July 4, 1922.

Fig. 3. Cross-section of Dyer 4½-in. full-hole continuous circulation joint (before lowering into well) showing how plug sealing mud inlet also holds valve in place

Fig. 4. Above the Dyer circulation joint is seen the hammer joint (with wedges) for quick-stabbing while adding a stand of drill casing

stabbing joint called a "hammer" joint (see Figs. 4 and 5).

Keeping the drilling bit on bottom and maintaining rotation of the drill pipe at all times except when changing bits and adding drill stem was assured by having all equipment duplicated and of the most substantial type. All possible precautions were taken to avoid a shut-down. In case any piece of equipment should break down a duplicate piece was all in readiness immediately to replace it. This duplication extended to all vital parts of the equipment such as the steam boilers, the drawworks, and the mud pumps.

In drilling through the troublesome shales the procedure adopted in maintaining circulation while adding a stand of drill pipe is of interest. No Kelly is used; in its place is a hammer joint below the swivel, below which is a Dyer full-hole circulation joint, and below that the upper stand of drill casing. As soon as the Dyer circulation joint reaches the position shown in Fig. 2 the rotary table is stopped and the drill casing hung on the slips. The plug shown in Fig. 3 is then removed from the Dyer circulation joint and the mud hose attached, a MacClatchie quick union being used to speed up the operation. Circulation is then begun through the Dyer circulation joint and circulation through the swivel stopped. This allows the flap valve (see Fig. 3) in the Dyer circulation joint to close. The wedges in the hammer joint are then knocked out (see Figs. 4 and 5) and while the next stand of drill casing is being picked up by means of the female end of the hammer joint, the male end of the hammer joint on the drill casing in the hole is unscrewed from the Dyer circulation joint. When the stand of drill casing is made up circulation is then begun through the swivel and stopped through the Dyer circulation joint. This permits the valve in the circulation joint to open. The plug is then screwed into the circulation joint to seal the mud inlet connection and also to hold the valve open (see Fig. 3). Rotation is then begun and drilling resumed with only a minimum loss of time and without a stoppage of circulation.

Two male ends of the hammer joint are used. The one removed from the drill casing in the hole is made up to the Dyer circulation joint on top of the stand in the rat-hole in readiness by the time the next stand of drill casing is drilled.

Before the hammer joint was developed it was the practice to make the hose connection to the Dyer circulation joint while the stand of drill casing was in the rat-hole. Difficulties in stabbing, however, with the hose connection on the circulation joint, led to the design of the hammer joint. Later, the practice of making up the hose connection on the circulation joint in the rat-hole was discontinued in favor of the present procedure.

With the mechanical devices and procedure here described, and the use of sodium silicate in the drilling mud the Continental Oil Company in its Moody 2-A, Calhoun County, Texas, is reported to have drilled successfully through more (heaving) shale than any other well drilled to date. Some 2000 ft. of shale was penetrated with 1600 ft. of 8⅝-in. 43-lb. stream-lined casing at a depth between 6000 and 8000 feet. The 8⅝-in. casing was set and cemented at 8021 feet.

This brief account of the chemical and mechanical aspects of the difficulties encountered and how they are being overcome does not permit including many important details. But it can be said that behind whatever success has been achieved is a story of intensive research concentrated on overcoming what at times seemed insuperable obstacles.

Fig. 5. Picture taken just after wedges have been knocked out (see Figs. 2 and 4)—note construction of the male end of hammer joint

Hardening of Cement Under Temperature and Pressure

Tests show the effect of temperature and pressure on cement strength up to age of three months.

By S. L. MEYERS

FROM the earth's surface a gradual increase of temperature is encountered with depth. Increase of temperature with depth is not a constant for all localities, but varies with each field and to a lesser extent with each well in the same field. The geothermal gradients of some oil fields are given about as follows:[1]

Balcones-Mexia-Luling belt of faults—One deg fahr., for 43 ft. descent.

Central mineral region and Southwest Texas—One deg. fahr. rise for 50 to 60 ft. descent.

West Texas Permian Basin and the Panhandle—An average rise of less than one deg. fahr. per 100 ft. descent.

Santa Fe Springs, California—A rise of one deg. fahr. for about 50 ft. descent.

Different authorities are not generally agreed on whether sub-surface temperatures are due to chemical action, faulting rock friction, radioactivity, or thermal flow from the depths of the earth to its surface; but regardless of cause, increase of temperature with depth is a condition whose importance will increase as drilling for production reaches continually greater depths; already there have been reports of temperatures of 200 and more deg. fahr. in some deep wells.

At depths of 6000 ft. and greater are met temperatures sufficiently high to alter the normal properties of hardening Portland cement-water paste.

Higher temperatures stiffen a cement-water paste, making it difficult to pump; the setting times and early hardening are accelerated and the later strengths of the hardened cement are not so great as they would have been under normal temperature storage.

The following results of tests on an oil well cement, of rather a quick-hardening nature, show how the temperature and combination of pressure and temperature affect the gain or loss of strength with time.

Previous work[2] showed that pressure hastened early hardening and somewhat reduced strengths below normal at later age, (in tests up to 28 days) but that temperature appeared to be far more effective in increasing early hardening and retarding the normal gain of neat grout at later periods.

Increased temperature speeds up hydration and hydrolysis of cement mineral compounds and the more cementitious material hydrated in the early stages the less unhydrated material there will be left to contribute to later hydration and gain in strength.

Where retrogression occurs a possible explanation is as follows:

In the normal course of hydration of cement colloidal, or glue-like, products are formed; in the early stages there is an entire absence of crystalline structure; next in time, it is assumed that sub-microscopic crystalline forms appear, which after long periods of time grow to microscopic size.

Where cement is hydrated under high temperatures, or under a combination of temperature and pressure, crystalline forms are visible at 24 hours and the too rapid growth of these crystals causes a disruptive force within the cement-jell the result of which is reflected in lower strengths of test specimens at later periods. In line with this reasoning, grouts of higher water content are affected less at later ages, because of their greater void space allowing crystal growth with less displacement.

The lack of proper gain of strength with age, and also the cause of non-uniform results, may be due in part to the brittleness of neat (without aggregate) cement specimens. This brittleness, noticeable at normal temperatures, is more pronounced at elevated temperatures and pressures; any slight imperfection in a test piece will not accommodate to the stress of applied load and fails locally, thus reducing the effective cross section of the test piece.

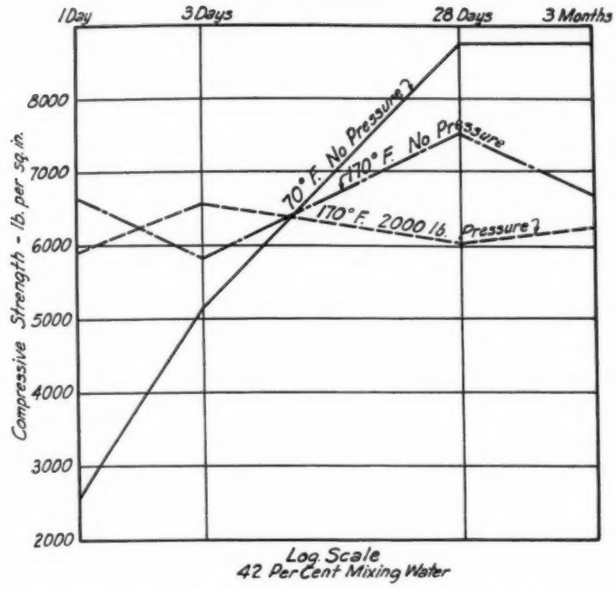
It is assumed in the foregoing discussion that brittleness increases with time and is also affected by storage conditions. Some investigators[3, 4] have found a difference between specimens broken hot and at 70 deg. fahr., and specify that

Tests on oil well cement showing the effects of temperature and pressure up to three months' storage

Test Condition	Percent Water	Tension				Compression			
		1 day	3 days	28 days	3 mo.	1 day	3 days	28 days	3 mo.
Water storage at 70°F. No pressure.	42	235	471	508	610	2555	5140	8750	8750
	50	230	446	465	467	1510	2525	5675	6750
	60	127	170	388	490	810	2120	3316	4150
Water storage at 170°F. No pressure.	42	372	282	290	242	6666	5810	7500	6700
	50	295	307	298	243	3300	3633	4373	3675
	60	205	248	277	220	1997	2710	2566	2675
Water storage at 170°F. 2000 lb. per sq. in. pressure.	42	257	288	252	285	5933	6575	6033*	6233
	50	243	305	212	280	3533	3500	3130	3910
	60	180	263	193	247	2600	2800	2737	3053

[1] "The Study of Earth Temperatures in Oil Fields on Anticlinal Structure," by K. C. Heald—A.P.I. Production Bulletin 205, October, 1930.

[2] "Behavior of Cement Grouts Under Oil Well Conditions," by S. L. Meyers—*The Petroleum Engineer*, July and August, 1935.



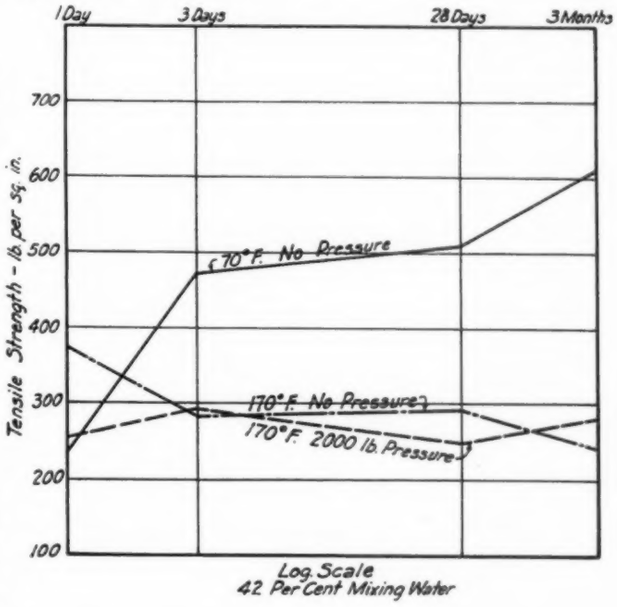
Curves showing effect of temperature and pressure on compressive strength of oilwell cement up to age of three months

test pieces be cooled to 70 deg. fahr., before breaking. In the tests shown here all high-temperature storage specimens were broken immediately on taking out of storage, since in practice the hardened cement in well must resist forces at its respective temperature.

Where temperatures above 120 deg. fahr. are encountered, finely-ground high-lime cements are unnecessary, and perhaps even undesirable. Coarse-ground cements with a low-lime composition containing a high percentage of dicalcium silicate will give sufficient early strength at elevated temperatures; but will not be completely hydrated and therefore will have a reserve for later continuous hydration and increase of strength with time.[5] This type of cement has the further advantage that it remains fluid longer than quick-hardening cements at high temperatures and allows more time to pump into place.

The writer is not sufficiently familiar with the geophysical conditions of oil fields and the mechanical demands on cement grouts hardened under those conditions to state whether or not there need be any alarm about the later performance of hardened cement having a tensile strength of 200 lb. per sq. in. or a compressive strength of 2000 lb. per sq. in. at the age of three months. Before Portland cement came into common use for shutting off water, many satisfactory shut-offs were obtained by such crude methods as the use of rubber, lead, and rope packers, landing and pounding the casing into an impermeable formation; and even sealing off by settling the proper kind of mud on the outside of casing.

With the use of cement we still have some obvious failures and probably many more that could be classed as failures if tested, or if it were possible to make them available for inspection. Those familiar with the properties of cement feel that not the cement but uncontrollable mechanical conditions or a lack of their understanding is at fault when failure occurs, and that the poorest of cements properly handled will be more satisfactory than the best of cements improperly handled. This, of course, should not be used as an excuse for not making or providing the best cement for a particular condition.



Curves showing effect of temperature and pressure on tensile strength of oilwell cement up to age of three months

[3] "Special Factors Must Be Considered in Selection, Specification and Testing of Cement for Oil Wells," by D. E. Silcox and R. B. Rule—*The Oil Weekly*, July 29, 1935.
[4] "Relation Between Strength of Portland Cement Mortar and its Temperature at Time of Test," University of Texas, Bulletin No. 2825.
[5] "Cement Investigations for Hoover Dam," *Journal A.C.I.*, June, 1933.

Southwestern District A.P.I. Meeting April 9-10

The spring meeting of the Southwestern District, Division of Production, American Petroleum Institute, will be held at the Washington-Youree Hotel in Shreveport, Louisiana, April 9th and 10th.

The program committee, of which R. D. Risser, Iowa, Louisiana, is chairman, has announced a tentative program, with speakers to be named later, and additional subjects under consideration. The program follows:

APRIL 9TH

Morning Session:

Registration.

1. Opening address.
2. The Rodessa oil field.

Afternoon Session:

1. Mechanical analysis of backside pumping installations.
2. Characteristics of producing sands, with special reference to the use of large gauge openings in the well strainer or production liner.
3. Some observations as to oil recovery and production on combination sulphur producing and oil producing salt domes.

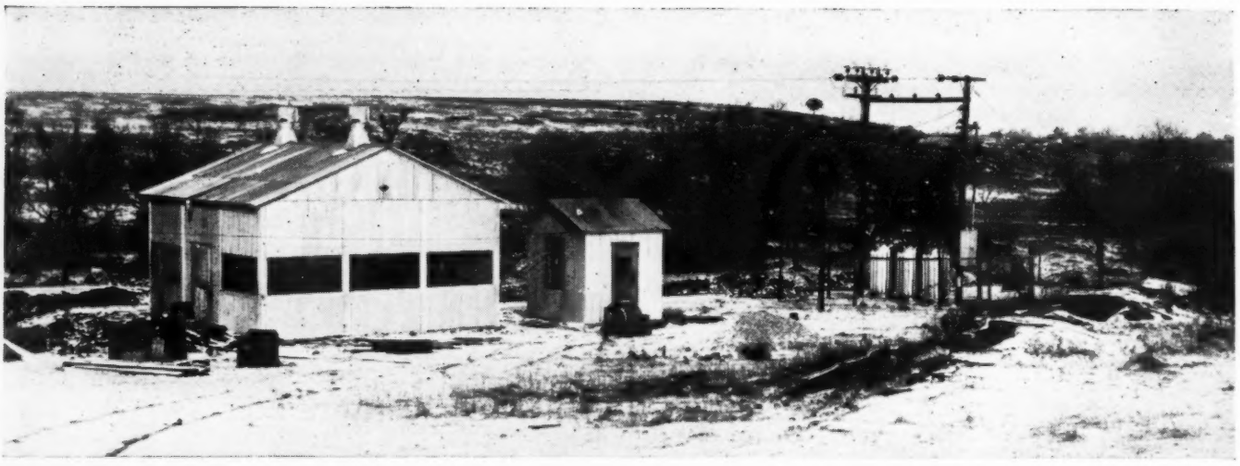
APRIL 10TH

Morning Session:

1. Progress of geological investigations in Louisiana, with special reference to the development of oil and gas production.
2. Recent developments and results in the drilling of heaving shale.

Afternoon Session:

1. Direct connected Diesel engine drilling rigs.
2. Mechanical analysis of various type rotary drilling rigs.
3. Discussion of special garments and accessories and their utilization with respect to safeguarding of oil field workers.



General view of one of the new stations installed by the Empire Pipe Line Company

Oil Pipe Line Stations Equipped With Compact High-Speed Pumping Units

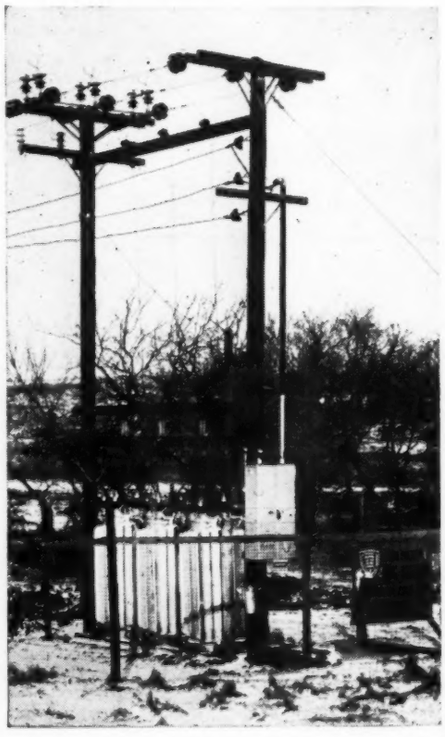
Electrically Driven and Controlled

By
FRANK H. LOVE

TO care for an increased movement of crude oil through its lines in southern Kansas and northern Oklahoma, the Empire Pipe Line Company has constructed and recently placed in operation two new pumping stations, one, the Holman station, six miles north of Arkansas City, Kansas, the other, known as the Black Bear station, approximately seven miles northeast of Perry, Oklahoma. Each has a capacity of 25,000 bbl. per day. As a part of the expansion program the Empire also has laid two 8-in. loops to its line, each six and one-half miles in length, between Cushing and Cimarron, Oklahoma, one near the Cushing station, the other near Cimarron. The loops, laid with reconditioned pipe taken from a line extending from Healdton, Oklahoma, to Gainesville, Texas, increase the capacity of the system from 37,000 bbl. to 43,000 bbl daily. This enlargement of its facilities is required to handle the extra load of western Kansas crude being delivered by the recently completed line of the Kaw Pipe Line Company.

The Black Bear station is pumping both north and south in order to supply the Ponca City refinery of the Empire with a certain volume of Oklahoma City crude, as well as that from Kansas. When pumping south the crude is from the fields of western Kansas and is delivered to the Empire at Valley Center, ten miles north of Wichita, for transportation to the Cushing station, whence it is sent both to Ponca City and to the company's East Chicago refinery. The Holman station pumps in but one direction, south, and for that reason has a somewhat different set-up from that of the Black Bear plant.

The stations, in keeping with the modern trend, employ compact, high-speed units, in contrast with the more massive equipment of a few years ago. Pumps are of the centrifugal type and the prime movers electric motors. At each station there are two 250-hp., 3-phase, 60-cycle, 2200-volt, 58-amp. induction motors of 3600 r.p.m. rated speed. To these are direct-connected pumps having a rated capacity of 1000 gal. per minute. At the Holman station the pumps are 6-in. 4-stage units, while the Black Bear station has one unit of that size and a 4-in. 3-stage



Electrical sub-station consisting of three 200-kva. transformers

pump. The pumps are arranged to operate either in series or separately. At Holman, since the flow of crude is in but one direction, they operate in series at all times. At Black Bear, however, there is the necessity of reversing the direction of flow frequently, so the units are used both in series and to operate singly. When used in the former manner each unit generates 800 lb. pressure, and when operating as single units each has a pressure of 400 pounds.

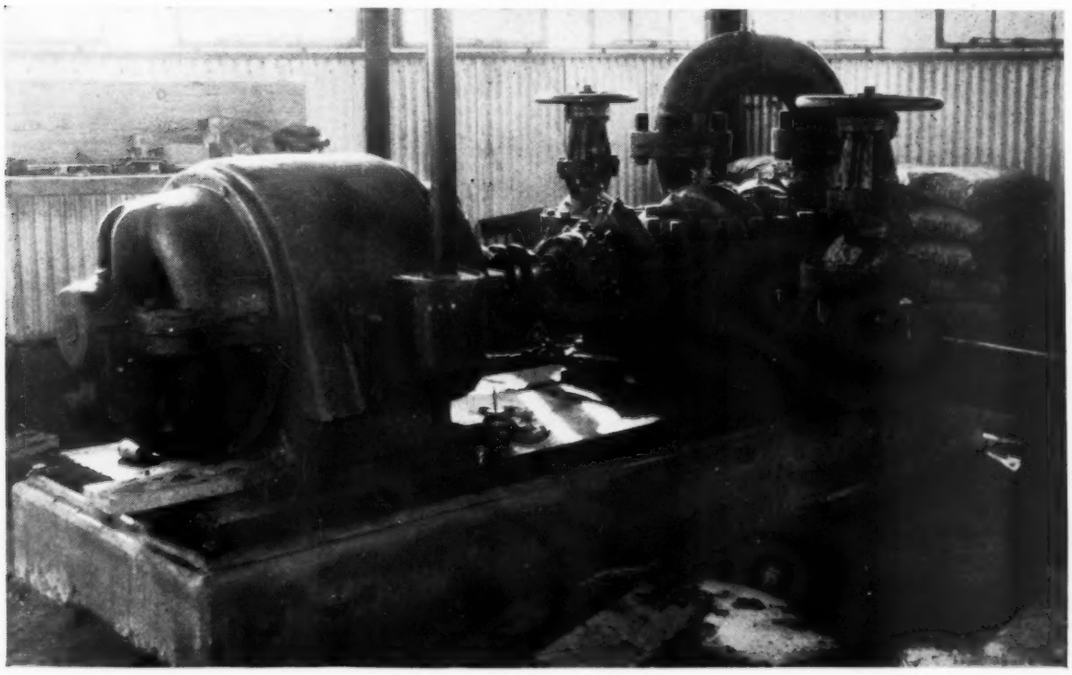
A feature of the stations is the fact that they can be entirely and efficiently operated from the control room, and an additional factor of interest is that, whereas the Empire Pipe Line Company has numerous electric stations throughout its system, this is the first time across-the-line starting equipment has been used by them on the size motors here employed. The 300-amp. entrance switch is solenoid-operated and equipped with overload coils for short circuit protection. The 200-amp. motor starting switches, of which there are two, are adjusted for a time delay of one and one-half seconds as protection against dips in current. Overload also is provided for, the thermal overload relays being connected into the current transformers, a departure from the usual method of hooking up the equipment. Ordinarily the trip coils are in series and solenoid-operated. The current breakers here described are used especially for the protection of induction motors and are designed to afford the greatest protection. All live parts are enclosed, connections are made inside the cover, and contacts are under oil. In the engine room are two stop push button stations, one for each pumping unit. At the Black Bear station all leads are housed in overhead conduits, while at Holman they are in conduits underground.

The electrical sub-station consists of three 200-kva. transformers. At Holman all three are in use, but at Black Bear two are in constant use while the third is employed as a standby. The main power line to the sub-station carries 13,000 volts. Three 2300-volt disconnect switches are mounted on poles at the transformers, and the equipment is such that the main power line leading to the station can be "killed" in case of trouble without affecting the lighting system, a factor that at times becomes of real value.

The principal station building is a 24-ft. square steel structure. All lighting fixtures and lamps are in vapor-proof housings, floors are of concrete, and the units are set on concrete foundations. To the rear of the station buildings, underground, is a sump to trap the oil lost from the packing glands of the pumps and from other sources. When the sump becomes filled a small electrically-driven plunger pump, operating automatically on a float switch, picks up the oil and boosts it into the suction side of the main pumping units. Each station also is equipped with strainers to clean the crude prior to its entering the pumps. These are double-barreled affairs, making it possible to clean one while the other unit is in operation.

Those in charge of maintenance of the electric stations on the Empire Pipe Line Company's system have found that a definite program of inspection is desirable in order to keep equipment operating at the highest degree of efficiency. The new stations, of course, will be subject to the same schedule that has been employed in connection with the older ones, consisting of a general inspection every two months. At that time all starting equipment is opened, switch contacts and oil in the switches examined; insulation tests are made on all equipment with a Meggar, a hand-driven generator having an ohm meter, which shows the resistance of the insulation and consequently its condition; and as a final step in the inspection procedure the air gaps are gauged on each motor.

The unit shown here is capable of pumping 25,000 bbl. of crude per day, operating singly or in series with a similar unit



Design of Sucker Rod Strings

Part 2

By EMORY N. KEMLER

Engineering Division, Gulf Research and Development Corporation, Assistant Professor of Mechanical Engineering, University of Pittsburgh

Two cases of sucker rod design are dealt with in this article. One when the pump size is to be changed and the other when the maximum load occurs during any part of the stroke.

Design of Sucker Rod String When the Pump Size Is to Be Changed

SINCE the maximum load occurs near the middle of the stroke in most wells, the formulas for this case will be treated first. The formulas for the design of the rod string in this case are more uncertain than when rod sizes only are changed. The approximate method to be given will be sufficiently accurate for most cases. The net oil load on the plunger is equal to the total dynamometer load less the weight of the rods; the net oil load being the difference between the fluid pressure on the top of the plunger and the pressure on the bottom of the plunger resulting from the fluid head in the well.

When the pump size is changed it is assumed that the net load will be proportional to the pump areas. This assumption implies the same ratio of gas to oil in the tubing column and that the fluid friction and rod friction are proportional to the plunger areas; also that the fluid level in the well stays the same and that the plunger friction is proportional to the plunger area. While these assumptions are obviously not necessarily true, each one of them is only a small amount in error and their total, ordinarily being a relatively small proportion of the total load on the plunger, makes the error introduced small.

The net load on the plunger will be given by:

$$W_{o1} = W - W_{r1} \quad - - - - - - - - - - \quad (38)$$

Where W_{o1} is the total oil load on the plunger before the pump size is changed, and W_{r1} is the average weight of rods per ft., other symbols are the same as in the previous article.

If the string is a tapered one the weight of rods is given by:

$$W_{r1} = W_1 l_1 + W_2 l_2 \quad - - - - - - - - - \quad (39)$$

If the pump size is changed the new oil load is given by:

$$W_{o2} = W_{o1}\left(\frac{A_{p2} - A_{r2}}{A_{p1} - A_{r1}}\right) - - - - - - - \quad (40)$$

Where A_{p1} is the plunger area before the change

A_{p2} is the plunger area after the change

A_{r2} is the rod area after the change

A_{r1} is the rod area before the change

W_{o2} is the oil load after the pump size is changed.

The total rod load is now given by:

$$W_t = W_{o1}\left(\frac{A_{p2} - A_{r2}}{A_{p1} - A_{r1}}\right) + W_{r1} - - - - \quad (41)$$

Fig. 5 has been developed to give the approximate value of W_{o2}. This chart assumes that the area of the sucker rod A_{r2} and A_{r1} is small compared with the area of the plunger. This chart gives in addition to the fluid load, as corrected for plunger area, the pressure in the oil column above the plunger and the percent by which the pump displacement is decreased.

In the case of a well pounding fluid, the percent of the pump stroke that is not filled with fluid can be measured on the dynamometer card and if desired the proper plunger size can be found from Fig. 5.

As an example of the use of the chart, assume that a 6000-ft. well weighing 21,000 lb. with 7/8-in. rods and 2-in. plunger is to have a smaller plunger in order to bring the maximum load down to 18,000 pounds.

The net oil load on the plunger then equals $21{,}000 - (6000 \times 2.26) = 7400$. This is to be reduced to 3400 lb. since the total load is to be reduced to 3000 pounds. Trace up for 3400 lb. on new oil load on plunger on Fig. 5 to 7400 lb. on diagonal scale for old oil load on plunger, then across to the left to the turning scale. Read on left scale that pump displacement, plunger area, and production are to be reduced by 54 percent. Trace up from turning scale until this line meets the horizontal line for old 2-in. pump; at this point read that 1 3/8-in. plunger is needed.

The problem can be solved analytically by substituting in Equation 41, remember that $A_{p2} = \frac{\pi d^2}{4}$. It is seen that while the solution is not difficult there is a considerable amount of numerical work required. If the area of the rods is assumed negligible the equation simplifies and reduces to:

$$d_{p2} = d_{p1}\sqrt{\frac{W_t - W_{r1}}{W_{o1}}} \quad - - - - - \quad (42)$$

Where d_{p2} is the new pump diameter

and d_{p1} is the old pump diameter

W_t being the desired total load.

If W_t is made less than the measured load the quantity under the radical sign is less than l and the pump size is reduced, whereas if it is larger the pump size is increased.

The following example will illustrate a more complicated type of problem. Assuming that a maximum working stress of 30,000 lb./sq. in. is allowable, it is desired to find what pump size can be used in a well 4000 ft. deep weighing 12,000 lb. and which has a 1 1/4-in. plunger and is to be changed to a tapered 7/8-3/4-in. string.

The present oil load found for $W_{o1} = 12{,}000 - (4000 \times 1.64) = 5440$ lb.

The maximum stress in the tapered string is given by S times A. The load in the rods will be $30{,}000 \times .60 = 18{,}000$ pounds. The length of 7/8-in. rods is approximately equal to 1/8 the maximum load or 2250 ft. and 1750 ft. of 3/4-in. rods are to be used. The oil load that can be carried in this

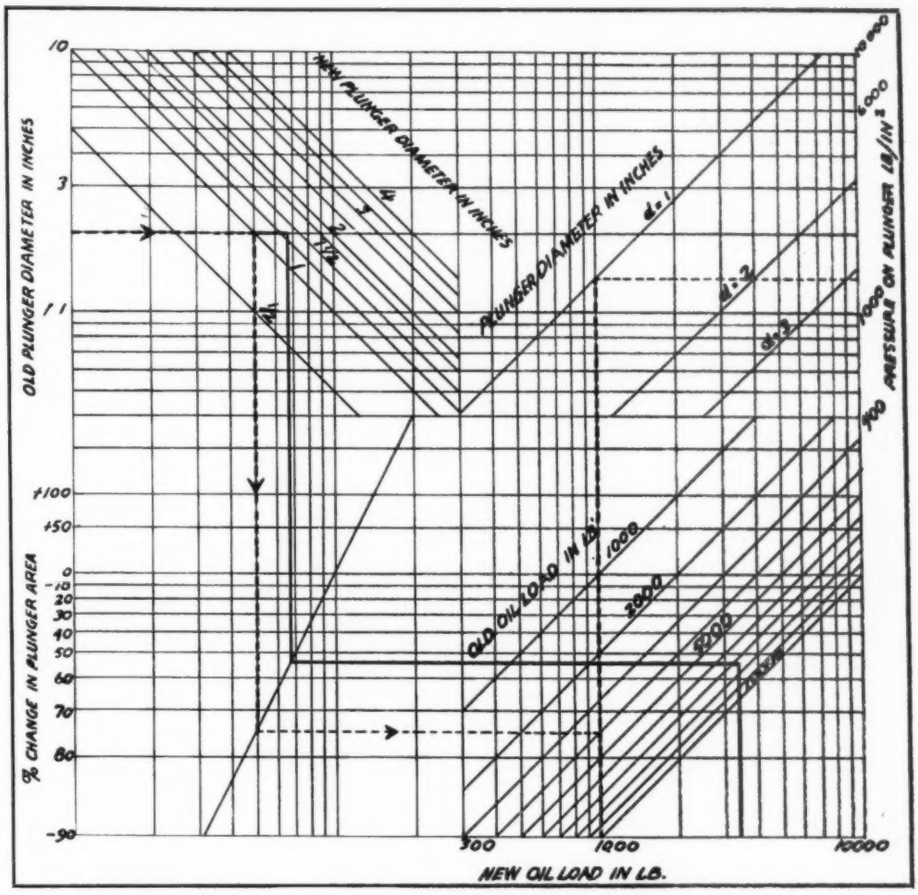


Fig. 5. Chart for determination of oil load as pump size is changed

case is given by $W_{02} = 18{,}000 - (2250 \times 2.26) + (1750 \times 1.64) = 10{,}000$ lb.

$$W_{02} = W_{01}\left(\frac{d_2^2}{d_1^2}\right) \text{ approximately}$$

$$= 5440 \times \left(\frac{d_2^2}{d_1^2}\right) \quad d_2 = d_1\sqrt{\frac{10{,}000}{5440}}$$

$= 1.75 \times 1.37 = 2.4$ in. diameter approximately.

Figs. 1 and 5 show that the production would be increased by 90 percent by this change.

If it is desired, an estimate can be made of the plunger, rod, and stuffing box friction and this can be subtracted from the total load before the correction is made for the plunger area, and then added after plunger correction is made.

To illustrate this, let us consider the previous example, except that the rod and plunger friction will be assumed as being 1000 lb. and will be considered the same after the pump size is changed. The oil load that can be carried under the new conditions will be 9000 lb. or just 1000 lb. less than was assumed before. The oil load before the pump size was changed would be 4440 lb. instead of 5440 pounds. The new plunger diameter would be given by $d_2 = d_1\sqrt{\frac{9000}{4440}} = 1.75 \times 1.44 = 2.50$ in. or a 2½-in. diameter plunger could be used. Fig. 5 shows that the production would be increased by about 140 percent. This assumes the well capacity to be large enough to supply this increased production, and that the pump volumetric efficiency will be the same after the change as it was before.

This example shows that the first method where plunger and rod friction were not subtracted gave a diameter a little less than that which could be used. This small difference gives a small margin of safety in the design, which is desirable.

General Case Where Maximum Load Occurs at Any Part of the Stroke

When the maximum dynamometer load occurs at any part of the stroke other than the middle the load at the top of the smaller rods in a tapered string or at the plunger for a uniform string will be the dynamometer load less the weight of rods and less the dynamic load of the rods at the time the maximum load occurs if the maximum load occurs before the middle of the stroke or plus the dynamic load of the rods at the time the maximum load occurs if the maximum load occurs after the middle of the stroke. If the motion of the polished rod is assumed as being approximately simple harmonic, the acceleration will be proportioned to the distance the maximum load occurs from the middle of the stroke.

The maximum acceleration is given by $\frac{1}{24}\left(\frac{2\pi N}{60}\right)^2 = .00046\ LN^2$ where L = length of stroke in inches and N = strokes per minute. For ordinary pumping speeds the maximum dynamic load is much less than the actual weight. For instance, at 20 s.p.m. with a 70-in. stroke the maxium acceleration will be 12.9 ft./sec.² and the maximum dynamic load will be $\frac{12.9}{32.2} = 40$ percent of the actual weight. Since the dynamic load is proportional to the distance from the center of the stroke, it is seen that the error will be small if the maximum load occurs near but not at the middle of the stroke. If the maximum load occurs before the middle of the stroke the length of rods based on the maximum load occurring at the middle of the stroke will be longer than necessary by a small amount. The simplified formulas based on the maximum load occurring at the middle of the stroke therefore gives conservative results if the maximum load occurs before that time.

In deriving the formulas given in this article it has been assumed that there is no time lag in the transmission of the motion along the rods. This is equivalent to assuming that every part of the rod column has the same acceleration. Actually there is a time lag in the transmission of the motion and therefore there may be not only a time lag in the transmission of the acceleration but the magnitude of the acceleration might also be different from that which occurs at the top. It had been shown in a paper for a new type dynamometer for the study of dynamometers that this time lag in the transmission of the motion has a considerable effect on the shape of the dynamometer card and one would expect therefore a corresponding effect on the rod acceleration at various points along the string. An exact solution of this problem is not practical but we are contemplating carrying out work with the use of an analogy that may make it experimentally possible to determine just what is happening at various points along the rod and oil columns. Until further information is available the formulas given can be applied but under some conditions they may not give rod strings that will operate satisfactorily because of the factors mentioned above. In this case it would be necessary to use larger rods or in the case of tapered strings it may be necessary to use longer lengths of larger rods.

A. Rods replaced by a larger or smaller string of uniform rods.

The total load on the top rod in this case will be given by the same type equation as (2) (see p. 34, January issue), except a dynamic load term is added or subtracted. We can therefore write:

$$W_1 = W + (W_1 - W_2)\, l \left(1 \pm \frac{a_x}{g} \right) \quad - - - - - \quad (43)$$

Where the symbols have the same meaning as in Equation (2) and a_x is the acceleration at point x where the maximum load occurs.

If x is measured from the center of the card, we have:

$$a_x = .00046\, LN^2 \times \frac{x}{L/2} \quad - - - - - - - - \quad (44)$$

and $g = 32.2$.

The plus sign applies if the maximum load occurs before the middle of the stroke and the minus sign if it occurs after the middle of the stroke. The absolute value of x is considered. The sign of x is always taken as positive.

On simplifying Equation 37 for a_x we get:

$$a_x = .00092\, N^2 X \quad - - - - - - - - - - - \quad (45)$$

From this it is seen that a_x depends only on N and X where X is the distance in inches of stroke that the maximum load occurs from the middle of the stroke. Fig. 6 gives a log chart from which a_x can be obtained when N and X are known.

B. Rods are to be replaced by a tapered string.

The formulas for this case will be similar to those of case 3, under section C (see pp. 35 and 36, January issue), except for the dynamic load factor.

The weight at the top of the smaller rods will become equal to:

$$W - W_2 l_1 \left(1 \pm \frac{a_x}{g} \right) \quad - - - - - - - - - \quad (46)$$

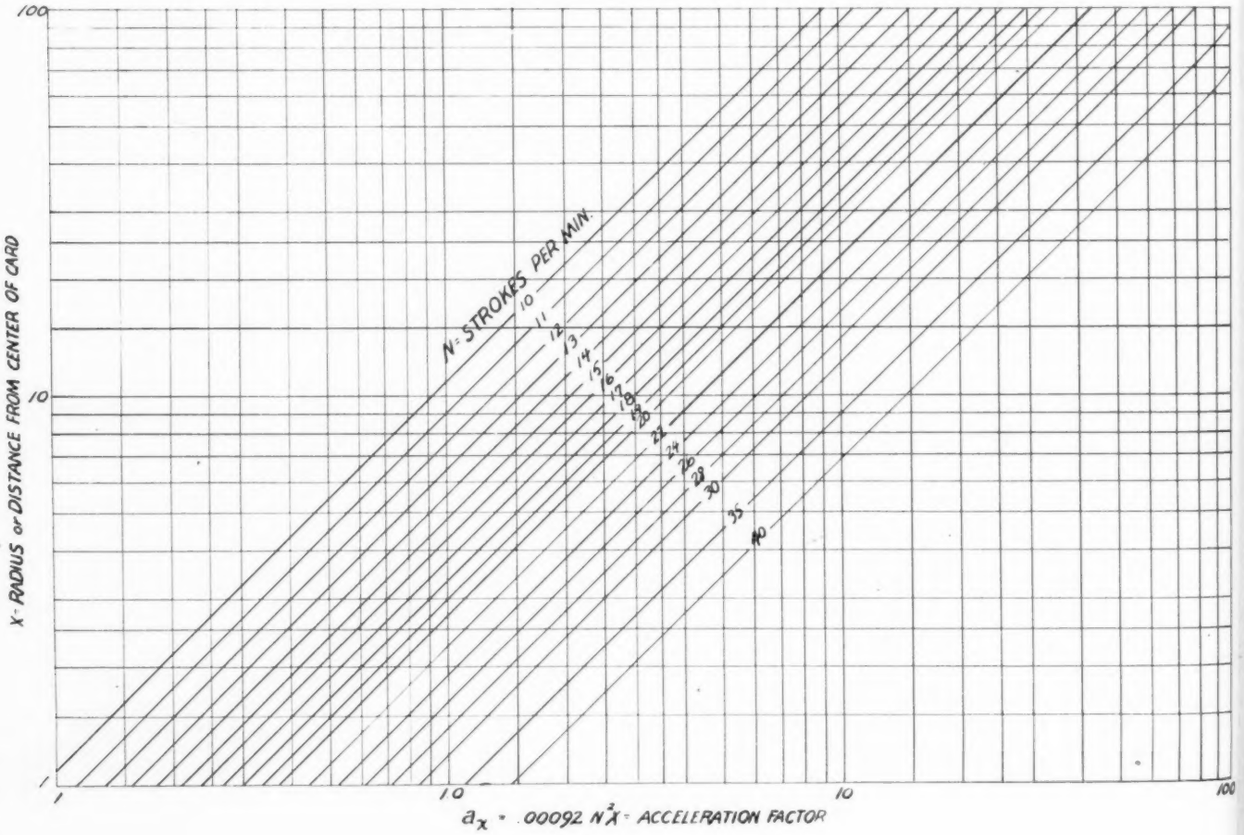
and the weight at the top of the larger rods will become:

$$W + (W_1 - W_2)\, l_1 \left(1 \pm \frac{a_x}{g} \right) \quad - - - - - \quad (47)$$

These equations are the same except for the factor $\left(1 \pm \frac{a_x}{g} \right)$, which it will be noted occurs always with l_1.

The equation for the length of larger rods will then become:

Fig. 6. Chart for determination of acceleration factor



$$l_1 = \frac{.126\ W}{\left(1 \pm \frac{a_x}{g}\right)} \quad \text{- - - - - - - - - - - - (48)}$$

for a $\frac{7}{8}$-$\frac{3}{4}$ string that is to replace a $\frac{3}{4}$ string and:

$$l_1 = \frac{.205\ W}{\left(1 \pm \frac{a_x}{g}\right)} \quad \text{- - - - - - - - - - - - (49)}$$

for a $\frac{3}{4}$-$\frac{5}{8}$ string that is to replace a $\frac{5}{8}$ string.

While this dynamic load factor directly increases or decreases the length of larger rods, *it does not affect the maximum stress or the maximum rod load.* This can be seen by substituting Equations 46 or 47 in Equations 44 and 45.

C. Tapered string.

Tapered string to be replaced by a tapered string with different length of larger rods to give equal stresses in each size.

Here again the equation can be easily deduced from those of section E (see p. 37, January issue). It will be noted that the dynamic load factor $1 \pm \frac{a_x}{g}$ should multiply each term containing a l_1 or l_2 applying this Equations 32 and 33 reduce to:

$$l_2 = \frac{.126\ W}{\left(1 \pm \frac{a_x}{g}\right)} - .0783\ l_1 \quad \text{- - - - - - - (50)}$$

for a $\frac{7}{8}$-$\frac{3}{4}$ string:

and $$l_2 = \frac{.205\ W}{\left(1 \pm \frac{a_x}{g}\right)} - .100\ l_1 \quad \text{- - - - - - - (51)}$$

for a $\frac{3}{4}$-$\frac{5}{8}$ string.

D. Pump size to be changed.

Here again the only change in the formulas is the value of W_{r1} or its equivalent $W_1 l_1 + W_2 l_2$. This factor need only be multiplied by the factor $\left(1 \pm \frac{a_x}{g}\right)$ or:

$$W_{o1} = W - W_{r1}\left(1 \pm \frac{a_x}{g}\right) \quad \text{- - - - - - - (52)}$$

Take as an example a well weighing 15,000 lb. with a tapered string of 2250 ft. of $\frac{7}{8}$-in. rods and 1750 ft. of $\frac{3}{4}$-in. rods and an allowable working stress of 30,000 lb. per sq. inch. The pump makes twenty 60-in. s.p.m., is 4000 ft. deep and has a $1\frac{3}{4}$-in. diameter plunger. If the maximum load occurs at the start of the upstroke it is desired to know how much the plunger size can be increased without overstressing the rods.

Equation 52 gives W_{o1} or the oil load on the plunger before the pump size is changed. Fig. 6 gives $A_x = 11$ for this case where the maximum load occurs at the start of the upstroke.

$$W_{o1} = [15{,}000 - (2250 \times 2.26) + (1750 \times 1.64)\,(1 + \tfrac{11}{32})\,] = 4200 \text{ lb.}$$

The maximum load that can be carried on the plunger will be 3000 lb. more than this, since the rods are not to be changed. Using Equation (42) we obtain:

$$d_2 = 1.75\sqrt{\frac{7200}{4200}} = 2.29 \text{ in.}$$

In making calculations with the formulas given in this paper, the assumptions that were made in deriving them should be kept in mind. While more refined calculations might be made, the complications that any more elaborate methods would introduce are not justified. Until such time as reliable experimental and theoretical work is available, formulas derived on reasonable assumptions as used here will have to be used in designing sucker rod strings.

(EDITOR'S NOTE: This concludes the discussion on design of sucker rod strings. Another article on counterbalancing and the use of dynamometer cards in determining the proper amount of counterbalance will appear in an early issue of *The Petroleum Engineer.*)

Petroleum Industry Searchimg for Oil Source

Man is still seeking the origin of oil, industrial lifeblood of today's machine age. Under the sponsorship of the American Petroleum Institute, the search for oil sources begun several years ago is being continued with the coöperation of scientific organizations, domestic and foreign government bureaus, and individuals.

Scientific research is being employed in seeking the source of oil where once the "wildcatter," or oil prospector, gambled by drilling undeveloped territory. It is believed that with further progress it will be possible to ascertain not only the sources of oil, but also to determine in what regions the chance of discovering hidden subterranean oil pools is greatest.

In the light of present knowledge, structure, sand, and source are requisites to an oil pool. Productive pools have been found on poor structure, and even treacherous sand conditions have yielded substantially, yet many wells have been drilled where both structure and sand conditions were favorable, but oil was lacking. Deficient source now is believed to explain the failure of the Tomball field on the Gulf Coast, of the Wheeler Ridge field in California, and of other fields, to produce satisfactorily despite favorable indications.

The research work in oil sources now is considered of vital importance not only in the search for new oil areas and fields, but also in connection with other studies, such as the migration of oil underground. While sporadic work has been done in studying migration, particularly as to how far and how rapidly oil can move through porous sands and rocks, definite conclusions cannot be reached until the origin of oil is known.

Under the direction of Dr. Parker D. Trask, of the U. S. Geological Survey, Washington, D. C., the Institute's research project began with a study of the oil-forming ability of the muds and sands of ocean bottoms. Virtually all known oil fields are in, or associated with, rocks that once were such muds and sands. In this study Dr. Trask and those coöperating with him analyzed samples of mud and sand taken from the bottom of the Seven Seas.

The second stage of the work, now in progress, involves collecting and studying the formations associated with known oil fields, the knowledge gained in the first stage being applied in the second. While those engaged in the task say that possibly five years remain before thorough understanding is reached and the origin and sources of oil are known exactly, the work of the past three years has narrowed steadily the broad field of theories as to the origin of oil. Each newly-discovered fact has been a direction marker pointing the course of new research.

Results obtained already have proved useful, and the work is seen as entering the stage where each year's findings not only will add to man's knowledge of the origins and sources of oil, but will be of material aid in solving many of the petroleum industry's production problems.

A Bureau of Mines Study of a "Bottom Hole" Sample from the Crescent Pool, Oklahoma

with Regard to Liberation of Gas, Expansion of the Oil-Gas Mixture, and Energy Relations Involved in Flow[1]

By BEN E. LINDSLY[2]

Part 2

METHODS OF GAS LIBERATION

TWO methods of liberating gas from an oil-gas solution (liquid mixture of hydrocarbons) by reduction of pressure are considered in this paper—differential liberation, in which the gas is removed from contact with the liquid as it is liberated, and flash liberation, in which the evolved gas remains throughout the process in intimate contact with the liquid from which it was released. These processes have been discussed by the writer[10] and will not be treated in detail here. It may be mentioned, however, that both are of interest in the production of petroleum because they represent ideal conditions which are approached by actual phenomena involved in oil operations.

As petroleum is produced from a natural reservoir some of the oil remains in the sand. The gas liberated from such oil tends to move away from contact with it. In general, there is little opportunity for this oil to commingle with the gas released from it or with gas from other sources. The oil that remains in the sand as depletion of a field progresses, therefore, is subjected to a process that partakes of the nature of differential liberation. On the other hand, as oil moves up the flow string of a well the gas released from it remains in intimate contact with the liquid. Although the gas may rise faster than the oil, all components of the fluid at the bottom of the well are present at the wellhead; hence the oil rising in a well is subjected to a process that is a close approach to flash liberation. The evolution of gas from the oil moving through the sand toward the well is more difficult to classify; probably it is not a close approach either to differential or flash liberation but lies somewhere between them.

Two forms of laboratory procedure for liberating gas from oil are referred to as differential and flash liberation, respectively, in following sections of this paper. It should be understood, however, that they are practical approaches to, rather than exact accomplishment of, these two methods of liberation. Full compliance with the definitions of differential and flash liberation would require steady evolution of gas, complete equilibrium between liquid and gaseous phases, uniform composition of the liquid and of the gas in the system, and, in differential liberation, removal from the system of each elemental unit of gas as soon as it is released from the oil. The laboratory methods described in this paper involve "stepwise" processes in which complete equilibrium and uniform composition of gas (or liquid) may not always be attained. However, they probably are as nearly representative of actual processes in oil-field operation as true differential or flash liberation would be.

Differential Liberation

Using differential liberation the quantity of gas released from the sample as the pressure is reduced and the shrinkage of the liquid as gas is evolved from it are measured by continuing the saturation-pressure determination. The same fluid and apparatus are used, the only change being that the manifold and pressure gage are removed and replaced by others that are completely evacuated. While this change is being made the lubricated stopcock at the top of the liquid-level gage (fig. 5) is closed.

Determination of gas liberation and shrinkage then proceed simultaneously. After approximately 3500 cc. of gas have been liberated slowly into a measuring bottle through the out-

[10]Lindsly, Ben E., Solubility and Liberation of Gas from Natural Oil-Gas Solutions: Tech. Paper 554, Bureau of Mines, 1933, 65 pp.

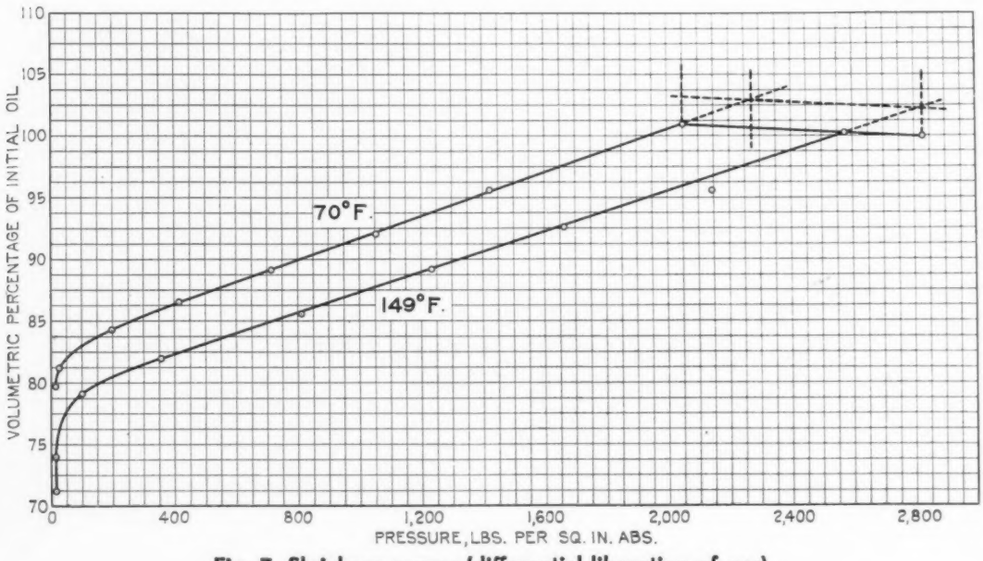


Fig. 7. Shrinkage curves (differential liberation of gas).

let valve on the manifold this valve is closed, and the pressure in the bomb is allowed to build up until no further change of pressure occurs over a 15-minute period. Liberation of gas then is continued by reptitions of this process. After the sample has been reduced to lower pressures the time required for stabilizing pressure increases, and this 15-minute period is extended to 30 minutes or even an hour.

The effect of time on the stabilization of pressure is determined by planning the work so that some of the periods of stabilization are during intervals of interruption, as at mealtime or at night. In all tests the final stabilization at atmospheric pressure is allowed to extend over 14 hours or more. After each period of stabilization the pressure is noted, and the volume of gas liberated into the measuring bottle is corrected for water vapor and reduced to base conditions, 70° F. and 14.4 lb./in.² abs. At the same time the oil level in the sight gage is read, and the space above the oil level is computed in accordance with volumetric calibration previously determined. Subtraction of the volume of this gas-filled space from the total volume of the container gives the volume of the oil. Figs. 7 and 8 are graphic representations of data obtained by the above operations.

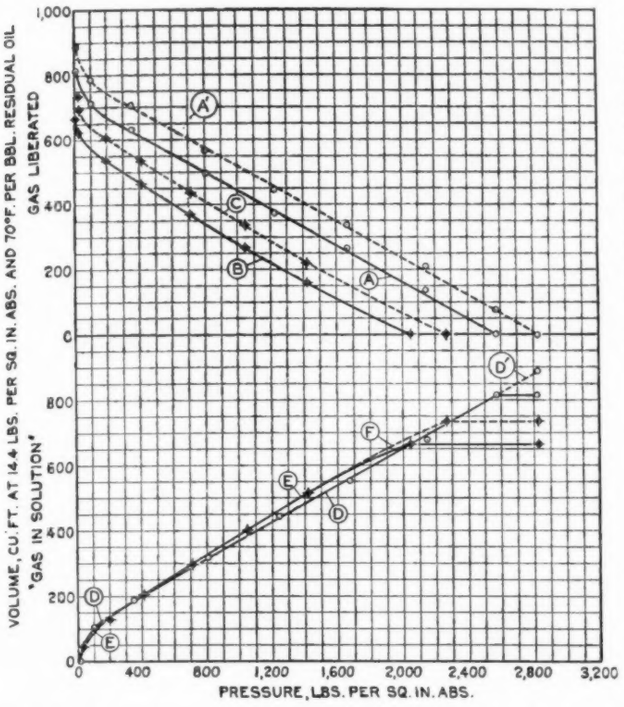


Fig. 8. Curves showing gas liberated and "gas in solution." (Differential liberation.)

A and D, gas liberated and "gas in solution" from test on sample at 149° F.
A' and D', estimates of gas liberated and "gas in solution" at 149° F., based on assumed complete saturation at 2829 lb. per sq. in. absolute (reservoir oil).
B and E, gas liberated and "gas in solution" at 70° F. from test on sample at 70° F.
C and F, gas liberated and "gas in solution" for sample at 70° F.
Depth of sampling, 6100 feet.
Pressure (6100 ft.) 2829 lb. per sq. in. absolute.
Temperature (6100 ft.) 149° F.
Saturation pressure at 149° F., 2575 lb. per sq. in. absolute.
Saturation pressure at 70° F., 2050 lb. per sq. in. absolute.

Shrinkage Data

The curves in fig. 7 show the reduction in the volume of the oil due to liberation of gas at temperatures of 70° and 149° F. The volumes at 2829 lb./in.² abs.—the reservoir pressure—are taken as 100 percent. The slight increase in volume shown at the upper end of each curve is due to expansion of the liquid upon reduction of pressure. The 70° F. shrinkage curve shows an approximately straight-line relation of volume of oil to pressure, at pressures between 417 lb./in.² abs. and the saturation pressure of 2050 lb./in.² abs.; the 149° F. curve shows a similar straight-line relation at pressures between 354 lb./in.² abs. and the saturation pressure of 2575 lb./in.² abs.

The equations of these straight-line portions of the two curves are:

$$v = 0.008796P + 82.93, \text{ for the } 70° \text{ curve,}$$

$$\text{and, } v = 0.00824P + 79.03, \text{ for the } 149° \text{ curve,}$$

where, v = volume of oil in percentage of the initial volume of the sample.

P = pressure, lb./in.² abs.

Table 1 records the data from which fig. 7 was developed.

In calculating oil reserves and efficiencies of recovery it is important to know the shrinkage of the oil in the reservoir due to liberation of gas from the oil as the pressure is reduced. An estimate of the total shrinkage from reservoir to atmospheric pressure can be made by extrapolating the 149° F. curve of fig. 7, but for purposes of calculation it usually is more satisfactory to determine the volume of the oil at any pressure above 354 lb./in.² abs. from the equation of the straight-line portion of the curve. According to this equation the volume of completely saturated oil at 2829 lb./in.² abs. would have been 102.34 percent of the volume of the undersaturated sample at the same pressure. The percentage of the initial volume to which the oil volume would be reduced upon reaching atmospheric pressure (taking the volume of a completely saturated sample at 2829 lb./in.² abs. as 100 percent) is

$$\frac{100}{102.34} \times 71.17 = 69.54.$$

The shrinkage then would be 100 — 69.54 or 30.46 percent.

Table 1.—Volumetric changes in oil due to differential liberation of gas

149° F.				70° F			
Pressure, lb./in.² abs.	Volume of oil, cc.	Percent of initial oil	Percent shrinkage	Pressure, lb./in.² abs.	Volume of oil, cc.	Percent of initial oil	Percent shrinkage
2829	269.16	100.00	00.00	2829	228.88	100.00	00.00
2575	269.83*	100.25*	— .25*	2050	231.09*	100.97*	— .97*
2144	257.16	95.54	4.46	1425	218.78	95.59	4.41
1666	249.16	92.57	7.43	1054	210.68	92.05	7.95
1233	240.06	89.19	10.81	715	204.08	89.16	10.84
813	230.36	85.58	14.42	417.5	198.13	86.56	13.44
354	220.56	81.94	18.06	199.3	192.88	84.27	15.73
101	212.96	79.12	20.88	28.7	185.88	81.21	18.79
14	199.16	73.99	26.01	14.0	182.58	79.77	20.23
14	191.57**	71.17**	28.83**				

*Expansion of liquid above saturation pressure.
**Volume of residual oil at 70° F. (estimated).

Gas Liberated and "Gas in Solution"

Curve A, fig. 8, shows graphically the quantity of gas per barrel of residual oil liberated between the reservoir pressure and various lower pressures when the temperature was held at 149° F. For example, the curve shows that while the pressure fell from 2829 to 800 lb./in.² abs. about 500 cu. ft. of gas was liberated per bbl. of residual oil (per bbl. of liquid remaining when the temperature and pressure had been reduced to atmospheric conditions).

Curve A originates at 2829 lb./in.² abs. (the reservoir pressure) and coincides with the pressure axis to 2575 lb./in.² abs. (the saturation pressure at 149° F.). There it departs from the pressure axis and shows an approximately straight-line relation between pressure and volume of gas liberated through a pressure reduction of approximately 2400 lb./in.² At about 175 lb./in.² abs. curve A departs from the straight-line relation, making a decided curve upward, and indicates at atmospheric pressure a total gas liberation of 814 cu. ft. per bbl.

The term "solubility" has been used in a rather loose sense with respect to phenomena like those discussed in this paper. The concept of simple solution probably is satisfactory, from a practical standpoint at least, when dealing with a gas such as methane or dry natural gas in association with dead oil. Such oil, though a complex mixture, is composed of hydrocarbons far removed in characteristics from those in the gas. However, in dealing with a natural oil-gas mixture, which usually will contain a gradation of hydrocarbons ranging from waxes to methane, the relations found should be considered from the standpoint of distributing the constituents of a complex mixture between coexisting liquid and gaseous phases. In studying the behavior of such mixtures under varying conditions of pressure, temperature, and volume the concept of solution of one simple substance in another is not adequate because a change in conditions of temperature, pressure, and volume not only will alter the relative amounts of the two phases but also will change the composition of each phase.

When the pressure on an oil, saturated with gas-forming constituents at an initial pressure, P_1, is reduced to a lower pressure, P_2, a certain quantity of gas will be liberated. With reduction to a still lower pressure, P_3, additional gas will be evolved, even though P_3 may be below the pressure of the atmosphere. The gas released between any two pressures was an integral part of the liquid at the higher of those pressures and, using the ordinary terminology of the industry, may be considered as gas in solution.

In the remainder of this paper, to simplify the terminology and conform to ordinary usage, even at the expense of using a term that is open to some technical objection, the expression "gas in solution" (at a given pressure and temperature) will be used to designate the quantity of gas that will be liberated from the liquid if the pressure on the sample is reduced to atmospheric, the temperature being held constant or changed to some designated value. Obviously the "gas in solution" will depend not only upon the composition of the sample and the temperature and pressure relations but also upon the manner of gas liberation.

Curve D, fig. 8, shows the "gas in solution" at different pressures, based on differential liberation at 149° F. In a sense curve D is the reciprocal of curve A. It is based on the fact that all gas liberated in reducing the pressure from 2829 to 14.4 lb./in.² abs. was in the liquid at the initial pressure of 2829 lb./in.² abs. The first point in the construction of the curve therefore can be designated by the coördinates: "gas in solution" = 814, pressure = 2829. The plotting of the other points on the curve is illustrated by the following example: As the pressure fell from 2829 to 1223 lb./in.² abs., 371 cu. ft. of gas per bbl. of residual oil was liberated, and as it fell from 2829 lb./in.² abs. to atmospheric pressure, 814 cu. ft. was liberated. The ordinate of 814 — 371 = 443 cu. ft. per bbl. of residual oil is plotted against the abscissa of 1223 lb./in.² abs.

As no gas was liberated between the pressures of 2829 and 2575 lb./in.² abs. the curve between these pressures parallels the pressure axis and corresponds to that portion of curve A which coincides with the pressure axis. The characteristics of curves D and A necessarily are similar, both showing a straight-line relation between pressure and volume of gas over a pressure range of 2400 lb./in.² The failure of these

Table 2.—Analysis of gas liberated at 149° F., by differential liberation

Pressures, lb./in.² abs.		Gas liberated, percent		"Gas in solution" at pressure of col. 2, percent	Analysis of individual fractions liberated, percent by volume							Volumes of components of individual fractions in percentage of total volume of gas liberated							Volumes of components of cumulative quantity of gas liberated at pressure of col. 2, in percentage of volume of all gas liberated							Volumes of components of "gas in solution" at pressure of col. 2, in percentage of volume of all gas liberated						
From	To	Individual fraction	Cumulative		CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	Total	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	Total (see col. 3)	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	Total (see col. 4)	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	Total (see col. 5)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
	2829			100.000																											
	2575			100.000																											
2829	2575	16.589	16.589	83.412	93.00	3.13	1.04	2.83			100.00	15.428	0.519	0.173	0.469			16.589	15.428	0.519	0.173	0.469			16.589	10.085	6.955	5.582	1.557	0.484	100.002	100.002
2575	2144	15.616	32.205	67.796	90.89	4.56	1.57	2.98			100.00	14.195	.711	.245	.465			15.616	29.623	1.230	.418	.934			32.205	19.566	6.782	5.113	1.557	.484	83.413	83.413
2144	1666	13.381	45.586	54.415	85.25	4.85	5.07	4.83			100.00	11.688	.649	.397	.646			13.380	41.311	1.879	.815	1.580			45.585	28.855	6.537	4.648	1.557	.484	67.797	67.797
1666	1283				+2.10*		−2.10*																			34.028	8.206	6.140	4.002	1.557	.484	54.417	54.417
1233	813	15.153	60.739	39.262	85.49	6.11	3.97	4.40	1.03		100.00	12.954	.926	.450	.067	0.156		15.153	54.265	2.805	1.265	2.247	0.156		60.738	21.074	7.280	5.690	3.335	1.401	.484	39.264
813	354	16.653	77.392	22.609	87.25	4.72	3.45	2.86	1.71		100.00	13.719	1.374	.799	.476	.285		16.653	67.984	4.179	2.064	2.723	.441		77.391	7.355	5.906	4.891	2.859	1.116	.484	22.611
	354				+3.53*	+3.53*	+1.37*																									
	101	10.003	87.395	12.606	63.57	20.51	9.89	4.22	1.45	0.36	100.00	6.359	2.052	.989	.422	.145	0.036	10.003	74.343	6.231	3.053	3.145	.586	87.394	.996	3.854	3.902	2.437	.970	.448	12.606
354	14	12.606	100.001	.000	7.90	30.57	30.95	19.33	7.70	3.55	100.00	.996	3.854	3.902	2.437	.971	.448	12.606	75.339	10.085	6.955	5.582	1.557	.484	100.002	.000	.000	.000	.000	.000	.000	.000
101	°																															
		100.001										75.339	10.085	6.955	5.582	1.557	.484	100.002														

*These figures indicate changes applied to original analysis to smooth out the curves. See text, p. 42.

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*These figures indicate changes applied to original analysis to smooth out the curves. See text, p. 42.

curves to show a straight-line relation between pressure and volume throughout the entire pressure range is discussed under the heading "Composition of Liberated Gas."

The equation of the straight-line portion of curve D at pressures above 354 lb./in.² abs. is:

$$q = 0.284P + 83.63,$$

where q = "gas in solution," in cu. ft. per bbl. of residual oil,

P = pressure in lb./in.² abs.

Extension D′, fig. 8, to 887 cu. ft. per bbl. of residual oil indicates the amount of gas that would have been "in solution" at 2829 lb./in.² abs. if the sample had been completely saturated at that pressure (reservoir oil). Curve A′ indicates the amount of gas that would be liberated, starting with a sample of reservoir oil saturated at 2829 lb./in.² abs. of sufficient volume to provide 1 bbl. of residual oil at atmospheric pressure.

Composition of Liberated Gas

Columns 6 to 11, inclusive, table 2, record analyses of the gas liberated at 149° F. in reducing the pressure through each of the steps indicated by columns 1 and 2. Column 3 records the volume of each of the individual fractions in percentage of the total volume of gas liberated through the entire range of pressure reduction from 2829 lb./in.² abs. to atmospheric pressure.

The plus and minus values that appear beneath the reported analytical data in columns 6, 7, and 8 were determined from curves for the various components plotted from the analyses. A study of these curves showed certain inconsistencies; for example, the gas liberated between pressures of 813 and 354 lb./in.² abs. was reported to contain a larger percentage of methane than either of the two preceding fractions liberated at pressures considerably higher. A graphic study of these gas analyses showed that where depressions occurred in the methane curve there were corresponding peaks in the ethane or propane curves and that by adding values to one component and subtracting equivalent values from others the curves became reasonably regular. These apparent inconsistencies in the gas analyses may have been caused by too rapid withdrawal of gas from the oil sample or by too rapid vaporization of the components liquefied at extremely low temperatures in the gas-analysis apparatus. The calculated results in columns 13 to 33, inclusive, table 2, are based upon the "corrected" values obtained by making the plus and minus adjustments indicated in columns 6, 7, and 8.

The values in columns 13 to 18, inclusive, indicate the volumes of the components of the respective liberated fractions, expressed in percentages of the total volume of gas liberated over the entire range of pressure reduction. For example, column 3 indicates that 15.153 percent of the total gas that came out of the oil was liberated in reducing the pressure from 1233 to 813 lb./in.² abs., and columns 6 to 11 indicate that the gas which was liberated during this pressure reduction had the percentage composition, methane 85.49, ethane 6.11, propane 2.97, butane 4.40, and pentane and heavier hydrocarbons 1.03. Taking 15.153 percent of each of these values it is found that the methane in this fraction accounts for 12.954 percent, the ethane 0.926 percent, the propane 0.450 percent, the butane 0.667 percent, and the pentane and heavier hydrocarbons 0.156 percent, of the total volume of all gas liberated over the entire range of pressure reduction from 2829 lb./in.² abs. to atmospheric pressure.

The volumes of the respective components of the total (cumulative) quantities of gas liberated during pressure reduction to each of the pressures listed in column 2, expressed in percentages of the total volume of gas liberated over the entire range of pressure reduction, are shown in columns 20 to 25. The volumes of the respective components of the "gas in solution" at each of these pressures, expressed in the same manner, are shown in columns 27 to 32.

Column 2, table 3, gives the quantities of gas per bbl. of residual oil liberated in reducing the pressure from 2829 lb./in.² abs. to each of the pressures listed in column 1. The figures in column 3, representing "gas in solution" at these pressures, were obtained by subtracting the respective values in column 2 from the total of 814 cu. ft./bbl. liberated in reducing the pressure to atmospheric. The volumes of the components of this "gas in solution" are given in columns 4 to 9, inclusive.

The volumes in columns 10 to 13, table 3, are estimates of gas liberated and "gas in solution," in terms of both residual and initial oils, for a sample saturated at the reservoir pressure of 2829 lb./in.² abs. It has been estimated (fig. 8 and text p. 42) that 887 cu. ft. of gas per bbl. of residual oil would be required to saturate the sample at 2829 lb./in.² abs. and 149° F. This is 73 cu. ft. more than the 814 cu. ft. that saturated it at 2575 lb./in.² abs. The volumes in column 10 are therefore obtained by adding 73 cu. ft. to each of the corresponding volumes in column 2 and are represented by the plotted points on curve A′, fig. 8. The volumes in column 11 were determined by subtracting each of the values in column 10 from the total of 887 cu ft.; they correspond to the plotted points on curve DD′, fig. 8.

The estimates based on initial oil in columns 12 and 13 were determined by multiplying the corresponding values in columns 10 and 11, respectively, by the factor:

$$\frac{1}{1.438} \quad \text{or}$$

0.6954 (table 1 and text p. 39) because 1.438 bbl. of oil saturated at 2829 lb./in.² abs. and 149° F. would yield 1 bbl. of residual oil. This may be verified by considering the reverse

Table 3.—Gas liberated and "gas in solution;" differential liberation at 149° F.

Pressure, lb./in.² abs.	Gas liberated per bbl. residual oil, cu. ft.	"Gas in solution" per bbl. residual oil, cu. ft.	Components of "gas in solution" per bbl. residual oil, cu. ft.						Estimates based on complete saturation at 2829 lb./in.² abs.			
			CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	Gas liberated per bbl. residual oil, cu. ft.	"Gas in solution" per bbl. residual oil, cu. ft.	Gas liberated per bbl. initial oil, cu. ft.	"Gas in solution" per bbl. initial oil, cu. ft.
1	2	3	4	5	6	7	8	9	10	11	12	13
2829									00	887	00	617
2575	00.00	814.03	613.28	82.09	56.62	45.44	12.67	3.94	73	814	51	566
2144	135.04	678.99	487.69	77.87	55.21	41.62	12.67	3.94	208	679	145	472
1666	262.16	551.87	372.14	72.08	53.21	37.84	12.67	3.94	335	552	233	384
1223	371.08	442.95	277.00	66.80	49.98	32.58	12.67	3.94	444	443	309	308
813	494.43	319.60	171.55	59.26	46.31	27.15	11.40	3.94	567	320	394	223
354	629.99	184.04	59.87	48.08	39.81	23.27	9.08	3.94	703	184	489	128
101	711.41	102.62	8.11	31.37	31.76	19.84	7.90	3.65	784	103	545	72
14	814.03	00	00	00	00	00	00	00	887	00	617	00

All gas measurements reduced to 14.4 lb./in.² abs. and 70° F.

TYPICAL LUFKIN INSTALLATIONS

Lufkin installation in the Oklahoma City Field; Lufkin TC-0-56 Unit with 130-lb. Beam.

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Lufkin TC-1A-58-1028-C Unit with 130-lb. Beam. Hercules engine. I. T. I. O. Corp., South Glendale No. 2, Oklahoma City.

T. C. Johnson Oil Co., Wichita, Kansas. Lufkin TC-3-22 Unit with G. E. enclosed motor.

Lufkin TC-5-7 Unit at County Line, Oklahoma.

Lufkin TC-2-26 Unit, Lorraine, Kansas. This photo not retouched—being entirely covered with ice gives retouching appearance.

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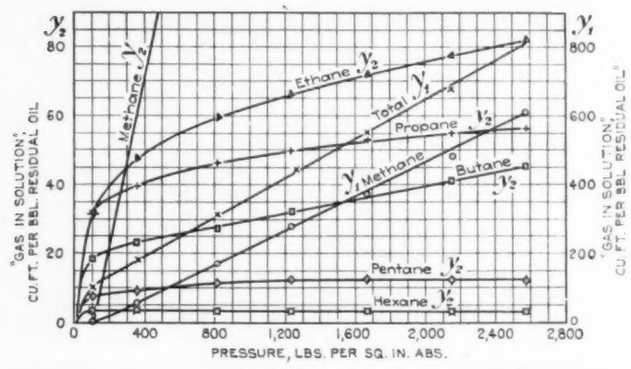

Fig. 9. Components of "gas in solution." (Differential liberation of gases at 149° F.)

of the liberation process, as follows: Starting with 1 barrel of residual oil and reabsorbing the gas, following line D, fig. 8, 814 cu. ft. would be absorbed at 2575 lb./in.^{2} abs., and the volume of the sample would be $\frac{100.25}{71.17} = 1.409$ bbl. (table 1 and fig. 7). Absorbing an additional 73 cu ft., bringing the total to 887 cu. ft., following curve D′, fig. 8, would raise the pressure to 2829 lb./in.^{2} abs. and increase the volume of the sample to $\frac{102.34}{100.25}$ of its volume at 2575 lb./in.^{2} abs. (table 1 and text p. 39), or $\frac{102.34}{100.25} \times 1.409 = 1.438$ bbl.

The data of columns 3 to 9, inclusive, table 3, are shown graphically in fig. 9, plotted against the pressures of column 1. The curve representing the total "gas in solution" is the same as curve D, fig. 8; the reason why this curve does not maintain the straight-line relation throughout the entire pressure range is found in the curves for the gaseous components heavier than methane. These curves indicate that the heavier components tend to remain in the oil until almost all the methane is liberated. After that the rate of liberation of the heavier gases increases rapidly.

It is interesting to note from the methane curve (fig. 9) that most of the methane had been liberated by the time the pressure was reduced to about 115 lb./in.^{2} abs.; also, that the low-pressure end of the methane curve is convex, whereas the others are concave, toward the vertical axis. However, at least traces of methane may be expected in the liquid at atmospheric pressure or even at a partial vacuum, as indicated by the following discussion.

Raoult's law applied to a mixture having liquid and gaseous phases in equilibrium may be stated in the form:

> "* * * the partial pressure of any component will equal the vapor pressure of that component in the pure state (at the same temperature) times its mole-fraction in the liquid * * *."[11]

As Hildebrand has said, in connection with Raoult's law:

> "If the gas is above its critical temperature, p° (its vapor pressure ceases to have any meaning as a saturation pressure, but by extrapolating the vapor pressure above the critical temperature a fictitious value of p° can be obtained, which can be used for an approximate calculation of the solubility of the gas."[12]

According to Dalton's law the partial pressure of any component is equal to the total pressure on the mixture times the mole-fraction of that component in the gaseous phase.

Although Dalton's and Raoult's laws cannot be applied quantitatively to a problem of the kind considered here without corrections for deviations from them they are helpful in indicating trends and qualitative relations. Applying Dalton's law and considering the analysis of the successively liberated fractions as shown in columns 6 to 11, table 2, it is evident that as the total pressure on the mixture is decreased the partial pressure of the methane will be reduced in a greater proportion because of the increase in the relative volumes of heavier hydro-

[11]Walker, W. H., Lewis, W. K., and McAdams, W. H., Principles of Chemical Engineering: New York, 1927, 2d edition, p. 583.

[12]Hildebrand, Joel H., Solubility: The Chemical Catalog Co., Inc., New York, 1924, p. 26.

Table 4.—Analysis of gas liberated at 70° F. by differential liberation

Pressures, lb./in.^{2} abs.		Gas liberated, percent		"Gas in solution" at pressure of col. 2, percent	Analysis of individual fractions liberated, percent by volume										Volumes of components of individual fractions in percentage of total volume of gas liberated										Volumes of components of cumulative quantity of gas liberated at pressure of col. 2, in percentage of volume of all gas liberated										Volumes of components of "gas in solution" at pressure of col. 2, in percentage of volume of all gas liberated									
From	To	Individual fraction	Cumulative		CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	Total	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	Total (see col. 3)	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	Total (see col. 4)	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	Total (see col. 5)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
2807				100.000							100.00	21.087	0.851	0.111	0.652			22.701	21.087	0.851	0.111	0.652			81.288	10.370	4.303	3.111	0.525	0.403	100.000
1988				77.299							100.00	16.049	.674	.136	.425			17.232	67.136	1.825	.247	1.075			60.201	9.519	4.192	2.459	.525	.403	77.299
1425				60.015																					39.983	44.152	8.845	4.056	2.036	.525	.403	60.017
1054											100.00	14.343	.697	.135	.299	0.015		15.489	51.479	2.222	.382	1.374	0.015		55.472	29.809	8.148	3.921	1.737	.510	.403	44.528
	715	15.489	55.474	44.526	85.34	11.76	1.93	.87	.10																							
					+7.20*	−7.20*																										
715	417.5	14.133	69.607	30.393	90.13	6.32	1.99	1.13	.26	0.17	100.00	12.738	.893	.281	.160	.037	0.024	14.133	64.217	3.115	.663	1.534	.052	0.024	69.605	17.071	7.255	3.640	1.527	.473	.379	30.395
417.5	199.3	11.134	80.741	19.259	86.65	7.87	2.94	1.74	.27	.53	100.00	9.648	.876	.327	.194	.030	.059	11.134	73.805	3.991	.990	1.726	.092	.083	80.739	7.423	6.379	3.313	1.383	.320	.320	19.260
199.3	28.7	12.896	93.637	6.363	38.84	33.12	17.20	7.18	2.30	1.66	100.00	7.423	6.379	3.313	1.383	.443	.320	19.261														
28.7	14.0	6.364	100.000	.000															81.288	10.370	4.303	3.111	.525	.403	100.000	.000	.000	.000	.000	.000	.000	.000
	*	100.000												4.303	3.111	.525	.403	100.000														

*These figures indicate changes applied to original analysis to smooth out the curves. See text, p. 42.

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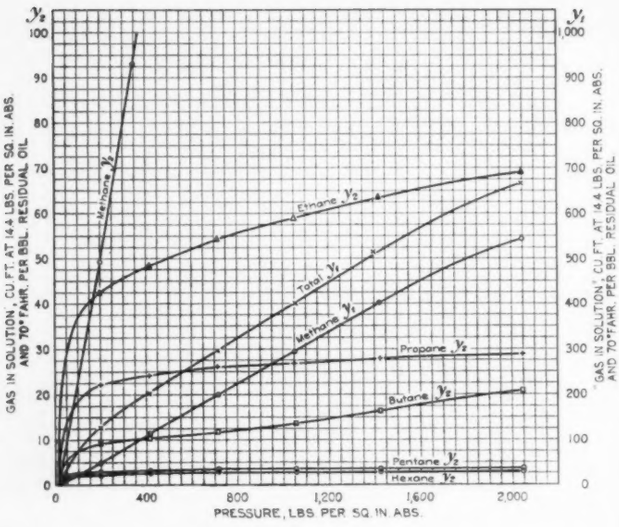


Fig. 10. Components of "gas in solution." (Differential liberation of gases at 70° F.)

carbons liberated. The fictitious extrapolated vapor pressure of methane for use with Raoult's law will have a large (but finite) value at the temperatures here considered. Applying Raoult's law, it is evident that with a low partial pressure and a high (extrapolated) vapor pressure of methane the mole-fraction of methane in the liquid will be small. However, since the total pressure on a volatile mixture of hydrocarbons cannot be reduced to zero, neither the partial pressure of methane nor its mole-fraction in the liquid can become zero until the other is zero, and both can become zero only when all methane is eliminated from the system. Therefore, as long as there is any methane in the system, traces (or more) of methane will remain in each phase. Dalton's and Raoult's laws may be applied similarly to the other components, indicating that each component will be present in each phase as long as any of it is in the system.

Tables 4 and 5 and fig. 10, based on differential liberation of gas at 70° F., are similar to tables 2 and 3 and fig. 9, which record the results of the 149° F. experiment. The curves of fig. 10 are based on the data in table 5 and show the "gas in solution," in terms of its components.

Table 5.—"Gas in solution," differential liberation at 70° F.

Pressure, lb./in.² abs.		"Gas in solution," cu. ft. per bbl. of residual oil						
From	To	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	Total gas
2829	2050	540.43	68.94	28.61	20.68	3.49	2.68	664.83
2050	1425	400.23	63.29	27.87	16.35	3.49	2.68	513.90
1425	1054	293.54	58.80	26.97	13.54	3.49	2.68	399.00
1054	715	198.18	54.17	26.07	11.55	3.39	2.68	296.03
715	417.5	113.49	48.23	24.20	10.48	3.14	2.52	202.06
417.5	199.3	49.35	42.41	22.03	9.19	2.96	2.13	128.04
199.3	28.7							42.31
28.7	14.0	00	00	00	00	00	00	00

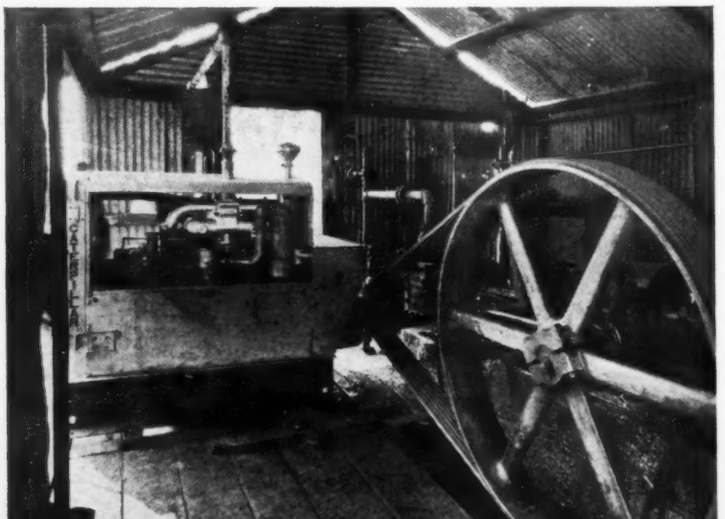
Note.—All gas measurements reduced to 14.4 lb./in.² abs. and 70° F.

Table 6.—Gas liberated per bbl. of initial oil measured at 2829 lb./ in.² abs. and 149° F. (differential liberation). Saturation pressures, 2575 lb./in.² abs. at 149° F. and 2050 lb./in.² abs. at 70° F.

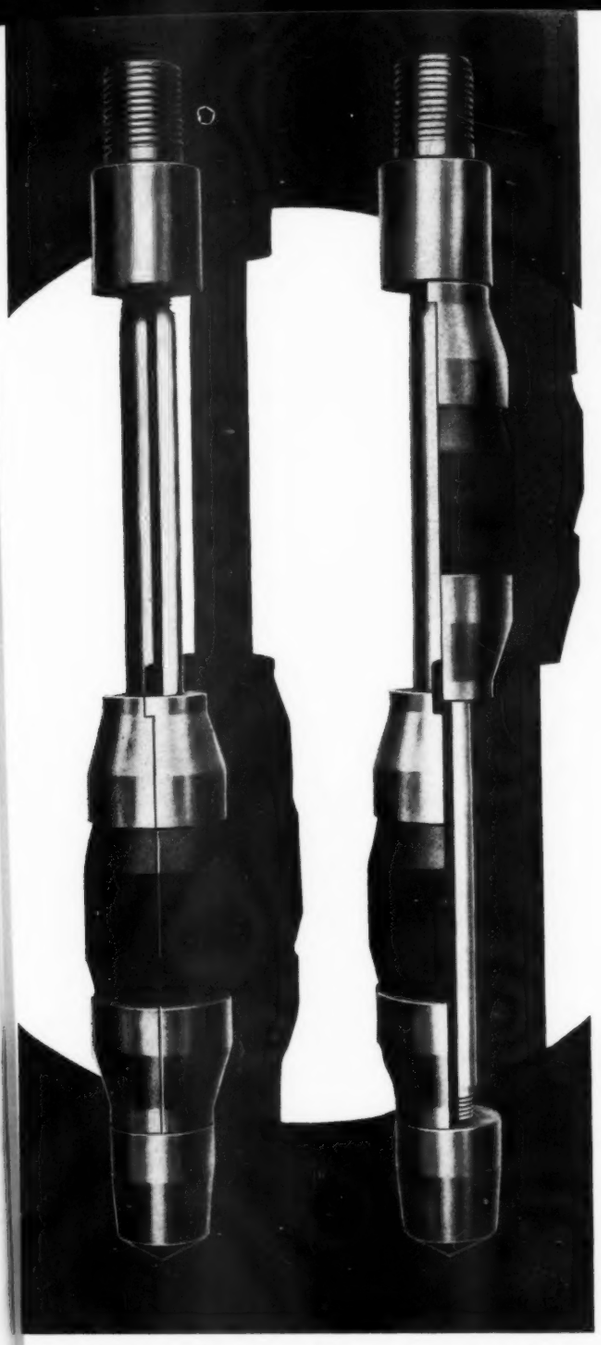
Components	149° F., cu. ft.	70° F., cu. ft.	Ratio
Methane	436.4	413.0	1: 0.946
Ethane	58.4	52.7	1: 0.902
Propane	40.3	21.9	1: 0.543
Butane and heavier	44.2	20.5	1: 0.464
Total gas	579.3	508.1	1: 0.877

Table 6 shows the volumes of the gas and its components, per bbl. of initial oil measured at 2829 lb./in.² abs. and 149° F., liberated in the two experiments. As is to be expected, the ratio of the volume liberated at 70° F. to that liberated at 149° F. decreases with an increase in the weight of the hydrocarbon. Considered individually, the hydrocarbons heavier than propane (grouped as "butane and heavier" in table 6) show some inconsistencies in this regard, but these probably are due largely to uncertainties in gas analysis.

Old Steam Engine Serves as Countershaft for Well Pumping Power Unit



AN old steam engine used as a countershaft to pump the 4100-ft. well of the McKeon Oil Co. on Signal Hill, Calif. The engine is belted to a 47-hp. gasoline unit.



The right hand illustration above, shows the Mission Valveless Open-Flow Swab as it falls in the tubing, with one-half of the swab rubber raised above the other to allow for fluid passage.

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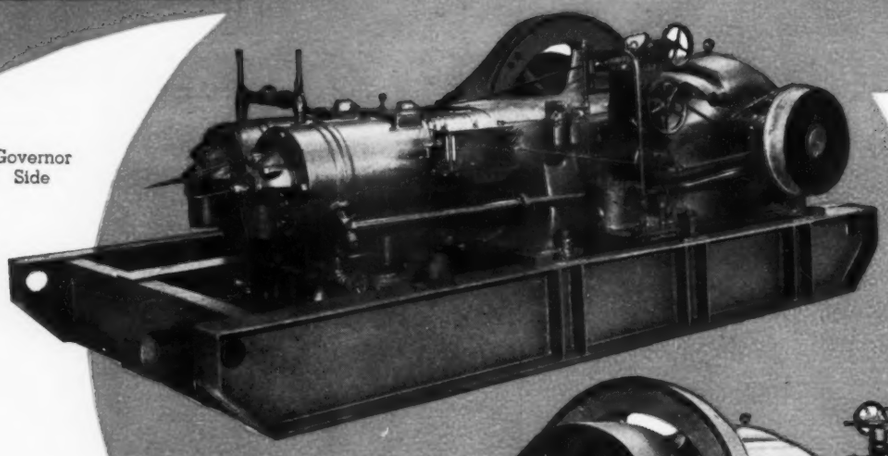
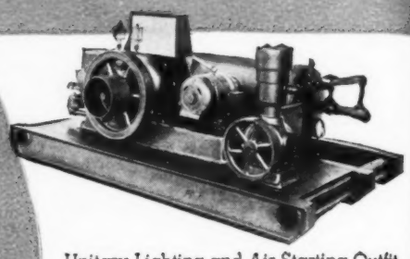


Governor Side



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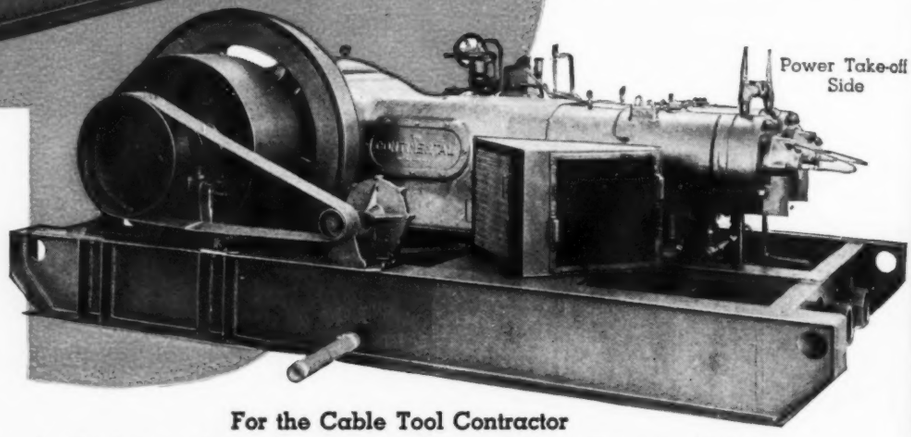

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Vacuum Equipment in the Oil Refinery

Part 2

By CHARLES T. CHAVE

FIG. 7 shows the characteristic of a two-stage steam jet air pump. Reducing the load does not greatly improve the vacuum. Considerable overloading will cause a rapid loss of vacuum. Thus a unit closely designed might experience serious fluctuations of absolute pressure if, for example, the amount of gas increased due to uneven furnace conditions, or water temperatures increased due to tidal conditions. This tendency of ejectors suddenly to drop the load often has mystified still operators.

For most petroleum distillation units, two-stage ejectors are used, as illustrated in Fig. 6. The actuating steam and condensable material from the first stage are condensed in the inter-condenser. It follows that, if the first stage handles a large amount of condensable vapors, the second stage may be of smaller capacity. When the amount of vapors that may be condensed in the inter-condenser is known to the ejector manufacturer, he is in a position to quote a more economical arrangement than if the total load is specified on a "dry air basis".

The following example is given of the calculation of an ejector load:

Example 1—Vacuum Distillation of Reduced Crude

Conditions:

Barometric Condenser Outlet Temperature 78.5°F.

Absolute Pressure = 35 mm. Hg

Vapor Pr. H_2O at 78.5°F. = 25 mm. Hg

Vapor Pr. Oil Vapor at 78.5°F. = 0.5 mm. Hg

$\left(\frac{\text{cf } 420°\text{F.}}{130 \text{ Mol. Wt.}} \text{ IBP}\right)$

Partial Pr. N.C. Gas = 9.5 mm. Hg.

Quantity of N.C. Gas = 90 lb./hr. 30 Mol. Wt.

(This is an assumed condition, dependent upon the size of the distillation apparatus).

Let x = mols per hr. of steam

Let y = mols per hr. of oil

3 = mols per hr. of gas

$\frac{x}{3} = \frac{25}{9.5}$ $x = 7.90$ mols or $7.90 \times 18 = 142$ lb./hr.

$\frac{y}{3} = \frac{0.5}{9.5}$ $y = 0.158$ mols or $0.158 \times 130 = 20.50$ lb./hr.

N.C. Gas = 90.00 lb./hr.

252.50 lb./hr.

check $\frac{x}{y} = \frac{25}{0.5} = 50 = \frac{7.90}{0.158}$

Total Load, 252.50 lb./hr.

Assuming that the inter-condenser ran at 100 mm. Hg,

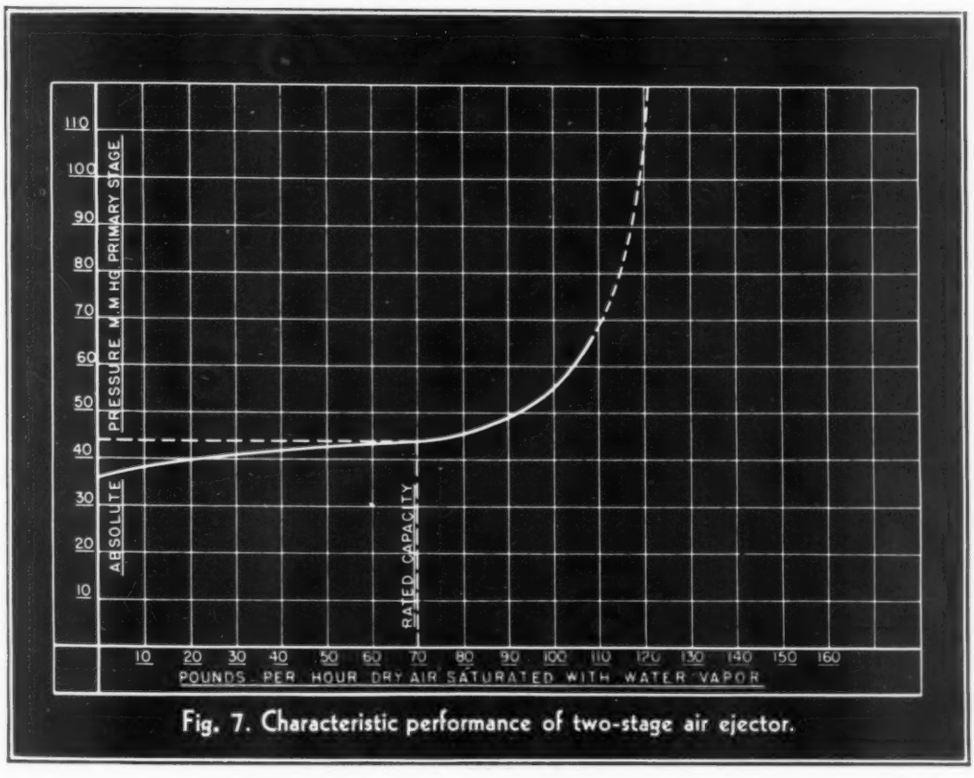

Fig. 7. Characteristic performance of two-stage air ejector.

with 92°F. vapor leaving, the load to the second stage would be as follows:

Absolute Pressure - - - - - -	100 mm.
Vapor Pressure Water - - - - -	38 mm.
Vapor Pressure Oil, Assume - -	1 mm.
Partial Pressure - - - - - - -	61 mm.

$\frac{x}{3} = \frac{38}{61}$ $x = 1.87$; $1.87 \times 18 = 32.7$ lb./hr.

$y = 1$ $y = 0.0492$; $0.0492 \times 130 = 6.4$ lb./hr.

N.C. Gas = 90.0 lb./hr.

129.1

check $\frac{x}{y} = \frac{38}{1} = \frac{1.87}{0.0492} = 38$

Load to Second Stage = 129.1 lb./hr.

Ratio of Loads = 252.4/129.1

= approximately 2 to 1.

From this illustration it can be seen that if the ejectors were purchased for 252 lb. of "equivalent dry air", the secondary stage would be twice as large as required.

One more typical example will illustrate the proper way to select ejectors where the oil exerts a high vapor pressure, as in a P.D. re-run unit.

Example 2—Vacuum Distillation of Pressure Distillate

Vapor and steam leaving condenser at 110.5°F., 90 mm. Hg:

90 lb. gas, 30 M.W.

10 mm. vapor pr. oil, at 110.5°F.

Oil = 140 M.W.

Vapor pr. water	= 66 mm. Hg
Vapor pr. oil	= 10 mm. Hg
P.p. N.C. gas	= 14 mm. Hg.
Total pr.	90 mm. Hg

$\frac{x}{3} = \frac{66}{14}$ $x = 14.1$ mols = 254 lb. steam

$\frac{y}{3} = \frac{10}{14}$ $y = 2.14$ mols = 300 lb. oil

N.C Gas = 90 lb.

check $\frac{x}{y} = \frac{14.1}{2.14} = \frac{66}{10}$ 644 lb.

It readily can be seen how large an oil loss is possible under these conditions, and this is why a wet vacuum pressure distillate unit cannot be run at low absolute pressure.

For oil distillation units, little data are available on the amount of dry gas that it is necessary to handle. Unlike steam condensers this amount does not depend largely upon leakage. The author has seen systems containing 5,000 cu. ft. leak air at the rate of only six pounds per hour, yet in operation they delivered upwards of 80 lb. per hour of N.C. gas. In general, light ends in the feed, and more especially cracking of the charging stock, produce most of the gas.

From 25 to 60 lb. per hour of 30 mol. wt. gas per thousand bbl. of feed per day should be allowed in rating ejectors for vacuum stills. Direct reference to a similar unit that has operated successfully should be made wherever possible. At the present stage of development, experienced gambling is the only known method of estimating the required ejector

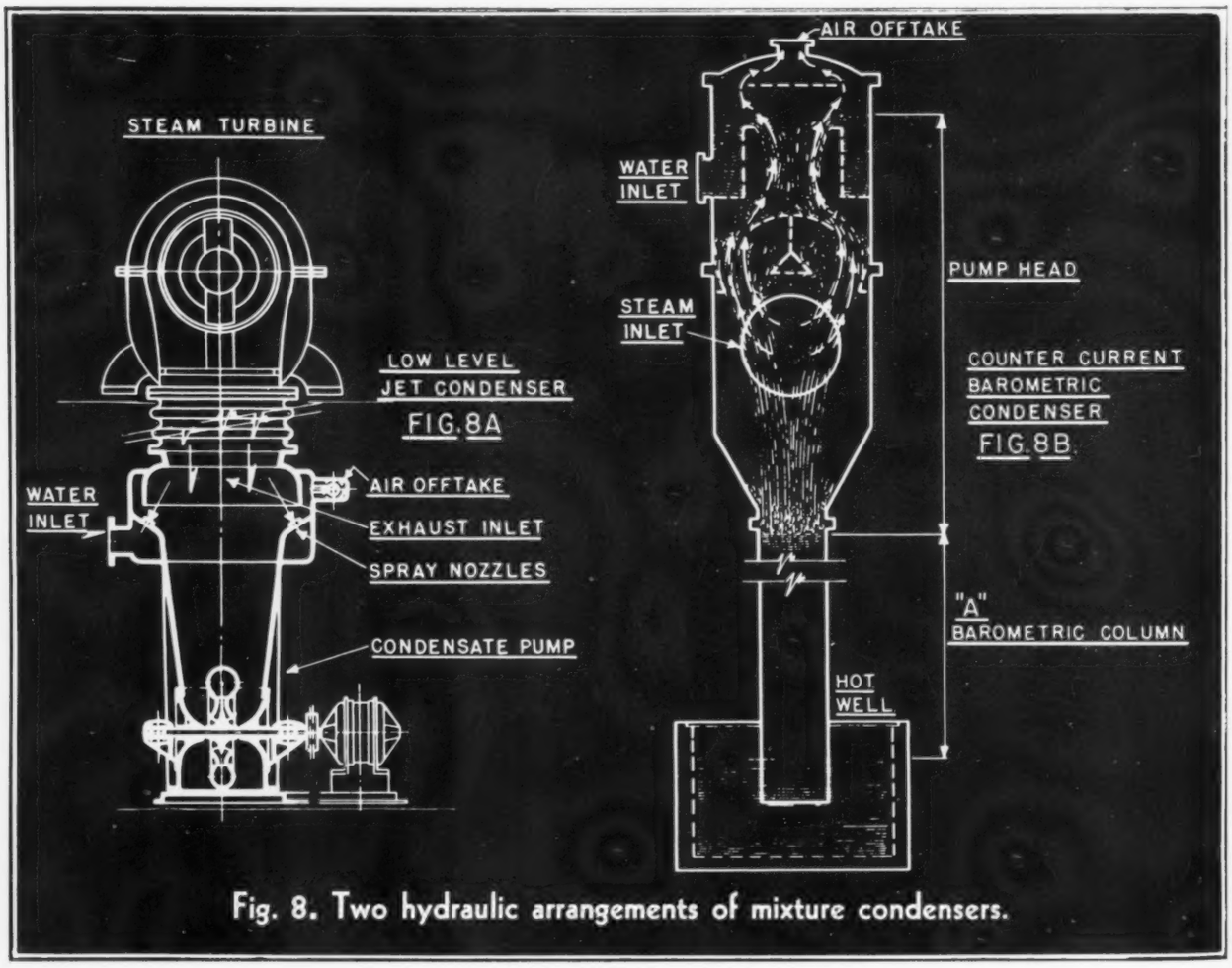

Fig. 8. Two hydraulic arrangements of mixture condensers.

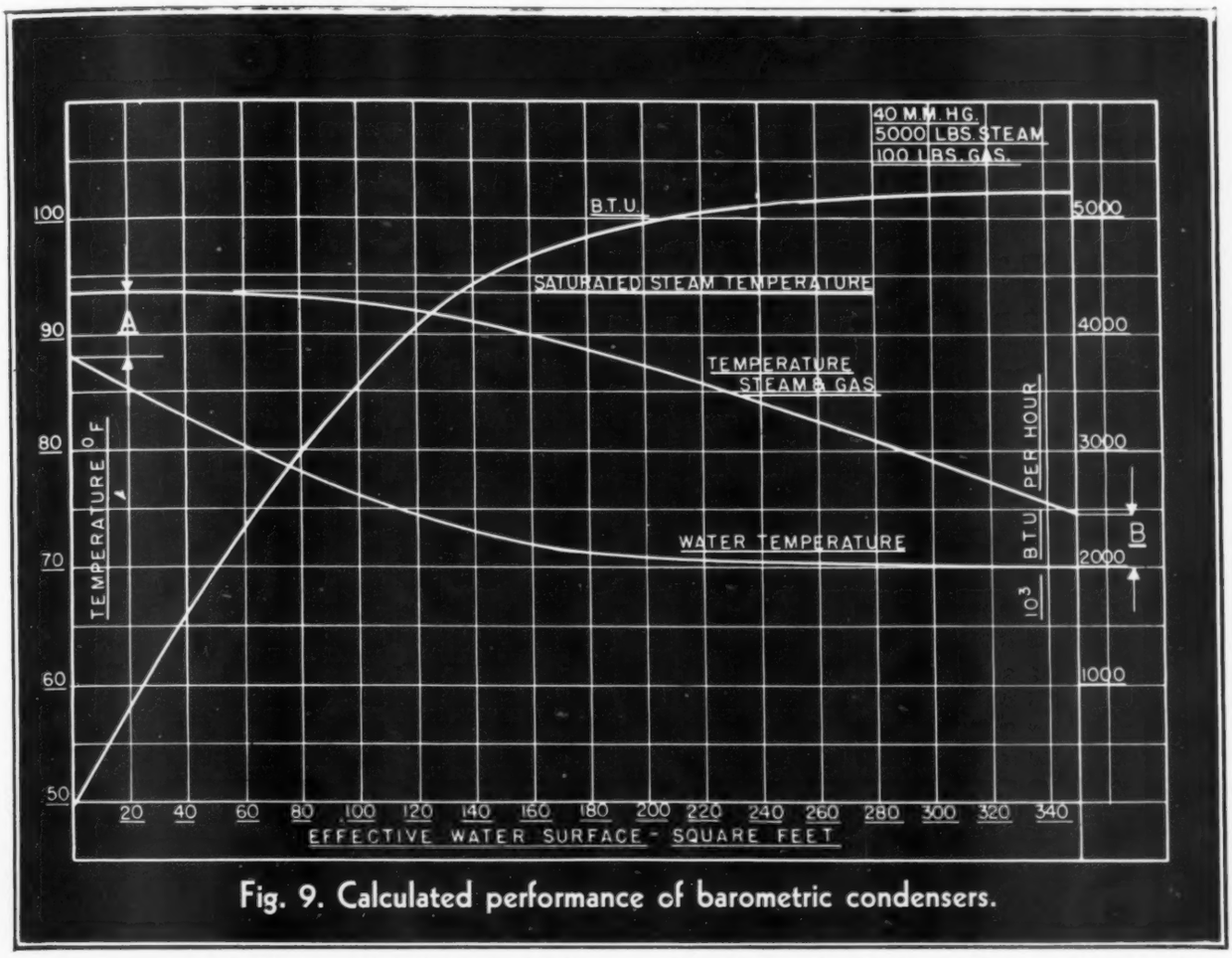

Fig. 9. Calculated performance of barometric condensers.

capacity. In no case should the total load be considered as dry gas. It may be that the failure even of manufacturers of ejectors to appreciate this fact accounts for the large discrepancies in steam consumption between different competitors on the same inquiry.

Operators can check the amount of non-condensable gas their still is delivering in three ways:

1. By reference to characteristics of the ejector. Determine:
   a. Absolute pressure at primary ejector.
   b. Absolute pressure in inter-condenser.
   c. Inter-condenser water inlet and outlet temperatures.
   d. Live steam pressure.
   e. Temperature of gas to ejector. Use a *bare* thermometer inserted in line through a cork and ½-in. valve. *Never* rely on thermometer wells for this reading. Do not take these data under the glare of the hot sun.
   f. Obtain a sample of exhaust from secondary stage and determine molecular weight. Use the primary ejector to draw this sample into the sampling bottle.

   With these data the manufacturer often can approximate the load rather closely.
2. By direct measurement with an orifice on the inlet side. An orifice designed to give 1-2 mm. Hg pressure drop may be installed in the line to the ejector. Heavy neutral oil is used in the manometer. Determine:
   a. Manometer reading.
   b. Sp. gr. of liquid used.
   c. Air temperature to ejector.
   d. Molecular weight of dry gas from secondary stage.

   With these data it is possible to calculate the flow through the orifice. Unfortunately, the orifice introduces an objectionable pressure drop into the system. Oil or light ends cannot be detected in the vapors being measured, since without an auxiliary air pump a sample of gas to the primary stage is unobtainable.
3. By direct measurement of exhaust with an orifice. If the ejectors have after-condensers, an orifice, or gas-well tester can be used to measure the atmospheric exhaust. As usual, temperature and pressure must be read and a molecular weight determination made. With this method, there is the chance of entrainment of gas by the inter-condenser water, so the result will always be on the low side. Otherwise, it is the easiest way to get a fairly reliable result. As usual, the presence of oil vapors in the primary stage load cannot be detected.

In all cases, a correction for water vapor of saturation must be made in order to determine the amount of dry gas.

A wealth of such data would be highly valuable to the whole industry, since:

1. The whole economic selection of vacuum equipment depends on a correct estimate of the non-condensables. With better data, the price of this equipment might be reduced.
2. The characteristics and amount of exhaust gas give a key to what is going on in the process. A refiner can tell if there is cracking in, for example, a lubricating oil re-run furnace. Oxidation by air infiltration, or possibly by stripping steam may be detected. Orsat analyses made by the author showed from 5 to 20 percent CO_2 in the ejector exhaust. Some of this is really H_2S, while some is definitely not H_2S, but probably the result of oxidation of the oil. Free hydrogen has been detected by other investigators,

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which suggests that under some conditions a water gas reaction may possibly occur to a limited extent.

Attention is called to the desirability of refiners making these tests, despite the uncertainties connected with the available methods, and publishing the results for their mutual benefit. Not only may the effect of steam and air leakage upon the product be more definitely established, but the operating expense may be eventually reduced by the closer selection of ejector equipment. From 0.25 to 0.5 lb. per gal. of process steam, and from 0.15 to 0.25 lb. per gal. of ejector steam are required. It may be seen that the ejector steam is a large proportion of the total steam required.

The basic element of a vacuum-producing apparatus is the ejector. A large enough ejector would function without a condenser. The aim in designing all vacuum equipment is to reduce the size of the required ejector to a minimum. The primary purpose of a vacuum condenser is to reduce the condensables in the non-condensable exhaust with as little pressure drop as possible. A direct contact steam condenser should always be considered in this light, and the absolute pressure at which a system is run should be selected with this in view.

Direct contact or mixture condensers are usually used for condensing process steam, since very large surface condensers would be required for this work. The countercurrent barometric type of jet condenser is employed, since:

a. The pumping costs are a minimum.

b. The countercurrent principle reduces the required air capacity.

Fig. 8 shows two hydraulic arrangements of mixture condensers. Fig. 8A shows a low level jet condenser. This type rests directly on the ground and water is pumped from the condenser against atmospheric pressure. The injection water is drawn in by the vacuum. Obviously this pump must work under a head of about 30 ft., depending on the vacuum. Fig. 8B shows a barometric condenser. The condenser must be elevated to such a height that the water can discharge from the barometric leg. Water at atmospheric pressure will rise to the height *a*, about 33 feet. The distance from this point to the water inlet represents the pumping head required. This is usually 10 ft.-15 ft.

Another striking difference between the two arrangements shown in Fig. 8 is the direction of the steam flow. By using a parallel flow arrangement in Fig. 8, in which the coldest steam-air mixture meets the hottest water, great advantages in equipment arrangement are obtained when jet condensers are used with steam turbines. This arrangement results, however, in a high degree of saturation of the air leaving the condenser, necessitating an external air cooler for large condensers. With countercurrent steam flow, as shown in Fig. 8B, the coldest vapor meets the coldest water. When large quantities of non-condensable gas are present in the steam, as is the case for oil refinery condensers, the countercurrent condenser must be used.

The barometric condenser problem looks easy. The average layman believes that steam condenses instantaneously upon contact with water. Unfortunately it does not condense immediately, and this leads to two philosophies of design which really amount to the same thing. One attack is to consider the *time required for the water and steam to be in contact in order for the steam to condense.* Another attack is to consider this as a problem in *surface* heat transfer and to calculate the heat transfer rate and the surface required. If we plot the temperature of water and steam versus the surface, as in Fig. 9, we obtain a picture of the problem. Due to the presence of non-condensable gas, the steam and gas mixture drops appreciably in temperature. The value of $(T_{sat} - T_{water\ outlet}) = A$ is known as the "terminal difference." The value of $(T_{gas\ outlet} - T_{water\ inlet}) = B$ is known as the "approach." These two values are important and interdependent. The smaller "A" can be made for a given discharge water temperature, the lower may be the saturated steam temperature and the possible absolute pressure. The smaller "B" can be made, the less the amount of water vapor carried to the primary ejector. These two temperatures are considered, in the trade, as the criteria of the performance of a barometric condenser.

The mean distance between the water and steam temperature lines is the MTD. This is *never* the log MTD. Using the heat transfer concept, the surface of exposed water is $\frac{\text{B.t.u./hr.}}{\text{Um} \times \text{MTD}}$ where Um is the mean overall heat transfer rate.

In dealing with condensation problems, it is more correct to speak of the mass transfer of the vapor rather than the heat transfer. The overall heat transfer rate is controlled by:

1. The diffusion of vapor to the water surface.

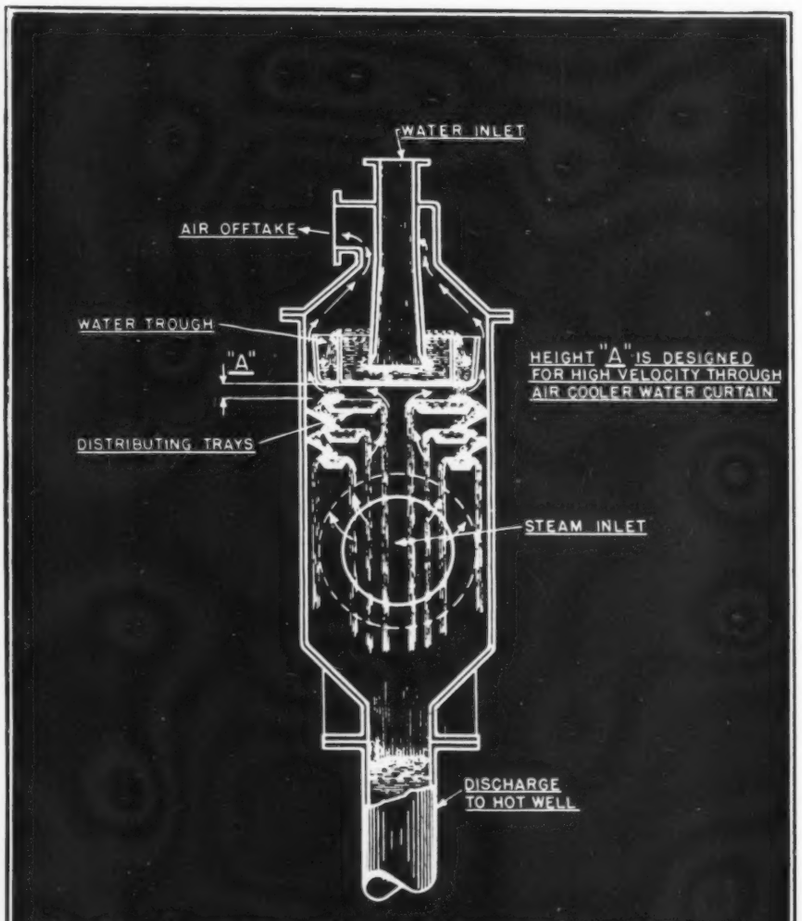

Fig. 10A. Barometric condenser with restricted vapor flow area.

2. The thermal resistance of the water.

Effect No. 2 is controlling for a fairly pure steam, as is to be had in a power condenser. Effect No. 1 is controlling when the amount of non-condensable gas is high.

The rate of diffusion of vapor to the water surface may be expressed as:

K = Lb. per hour per sq. ft. per mm. Hg partial pressure difference.

Lb. steam condensed per hour = KA × Pm

where

A = Water surface and

Pm = Mean difference in partial pressure of steam and partial pressure exerted by water surface.

It can be seen that if the water is hot at the surface and cold in the center of the stream, the mass transfer rate "K" is reduced. This happens when the steam is very pure and the water side rate becomes controlling.

The value of the mass transfer rate at any point in the condenser depends upon:

1. Mass velocity.
2. Hydraulic diameter, or the ratio $\frac{\text{Vol. of Container}}{\text{Sq. ft. of Surface}}$
3. Inversely as the partial pressure of the non-condensable gas.

The third effect, the partial pressure of non-condensable gas, is uncontrollable in the design of a barometric. It is often controllable in the design of the process. For example, running cracking still tar to a vacuum tower without a preliminary flash is illustrative of bad practice in this respect.

Increasing the mass velocity is a practice that often results in a pressure drop in the condenser, partly defeating the purpose of a low approach. However, at the outlet end of the condenser the partial pressure of non-condensable gas is so large that the mass transfer rate becomes very small if only natural convection velocities prevail. Colburn and Hougen give, for an air and steam mixture, the value

$$K = 2.36/Pg.$$

At the condenser inlet, Pg may be 1 mm. or less. The controlling resistance is then undoubtedly on the water side. At the outlet, Pg may be 30 mm. or more. It is therefore necessary to follow one of two courses in design:

a. Take a pressure drop, using high vapor velocities, particularly at the cold end of the condenser.

b. Greatly increase the physical proportions and the exposed water surface in the condenser.

The area of the exposed water surface in a condenser depends upon the quantity of water, the extent of subdivision, and the time in the condenser. The problem of design is to favor the maximum exposed water surface and the maximum heat transfer rate.

As a matter of fact, there are three characteristic designs on the market, as illustrated in Fig. 10. Type A is typical of a "pressure drop" condenser. It is usually offered with considerably less height and weight and a much better approach guarantee than Type B. When it is overloaded with non-condensables, or with oil vapors, which have the same effect, the pressure drop greatly increases, with oftentimes little change in the gas outlet temperature.

Type B operates with little or no pressure drop. The writer has seen these condensers operate with no noticeable deflection of a kerosene manometer connected between the steam inlet and the air discharge. When they are overloaded, the gas discharge temperature rises, and more condensables are carried to the ejector. The absolute pressure in the system rises due to the increased ejector load. Type B has the disadvantage that the ejector load may increase to the "breaking point" on the characteristic curve of the ejector, and the ejector will cease to function. On the other hand, an overloaded job can be fixed by the following methods:

a. Add an additional barometric as an external air cooler.

b. Add additional ejectors.

With Type A, it is very likely that the pressure drop will increase due to overloading to a point where additional ejectors or external air coolers will do no good. On the other hand, with Type B it is inherently difficult to get a large water surface per unit of volume, unless a complicated hydraulic arrangement is used. In some designs of this type, a series of slotted trays are so arranged one above the other as to produce a dense rain in the condenser, through which the steam passes. Another device is to use "disk and doughnut" pans with many small holes drilled in the bottom. These condensers give, in theory, very much higher effective water surface than most conventional types, but often rapidly plug up with dirt and become ineffective.

However, the writer has seen a condenser of this type, in service some months on Mississippi River water, that operated

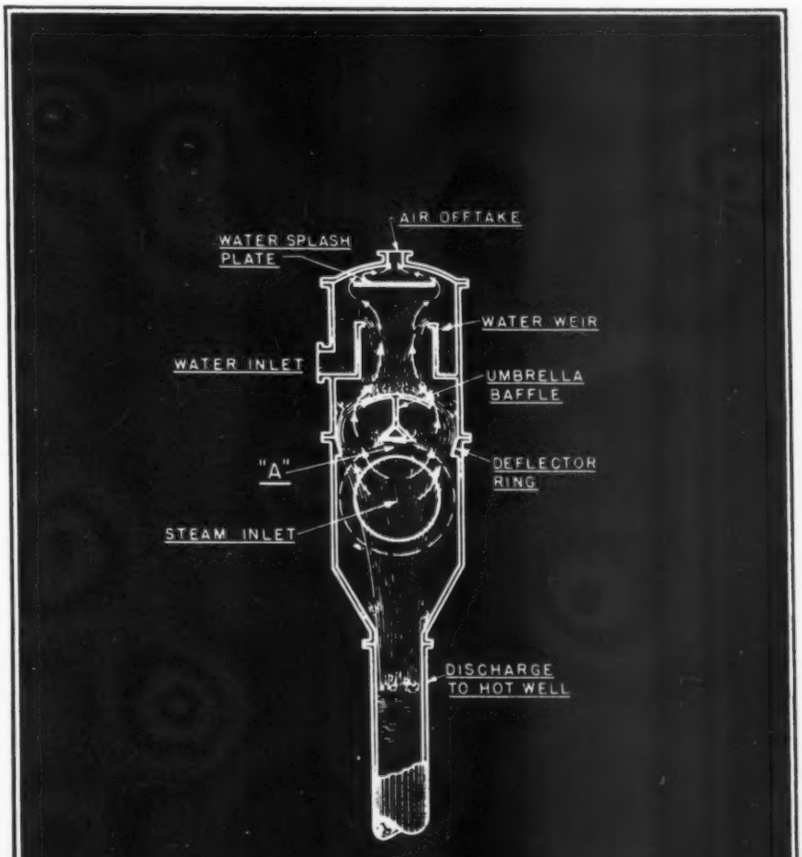

Fig. 10B. Barometric condenser with large vapor flow area.

with a terminal difference of 5 deg. fahr., an approach of less than one deg. fahr., and a pressure drop of less than one mm. Hg.

We are at once led to another method of classifying barometrics; i.e., by the method in which the water surface is exposed. Type B, Fig. 10, shows the use of umbrellas and circular weirs to give a conical sheet of water. Such sheets must be broken to permit the steam to enter, otherwise they will be unstable. The angle piece (A) in Fig. 10B is a valuable patented feature of this condenser, for it permits the stability of the water curtain.

In Fig. 10A we see a series of circular notched weirs, which give a rain in the condenser.

All these processes require *height* in a condenser to give surface. When water is discharged in streams, or in films, as from a weir, the velocity of the water increases as it falls, the stream contracts, and less and less area per foot of height is presented the farther it falls. A rain likewise gives less effective surface per foot of height the farther it falls, since the drops get farther and farther apart. Likewise, surface temperature of the droplets is rapidly raised, but due to the lack of turbulence and the low thermal conductivity, the heat does not penetrate toward the center. Hence frequent interruptions of the fall of the water increase the effectiveness of the condenser in two ways: by increasing the exposed water surface, and by causing turbulent mixing at frequent intervals.

The most effective way in which to increase the water surface is to spray the water. This device is used in most power condensers because of the limited space available. It has the disadvantage of considerably increasing the pumping head, and being sensitive to debris in the water.

A spray design using a non-clogging nozzle is shown in Fig. 10C. The unique feature of this condenser is that a series of orifices are used to "shave" off a flat sheet of water from the rising jet. The steam passes through the very thin stable high velocity films of water, and good contact is obtained. This condenser operates satisfactorily when out of plumb.

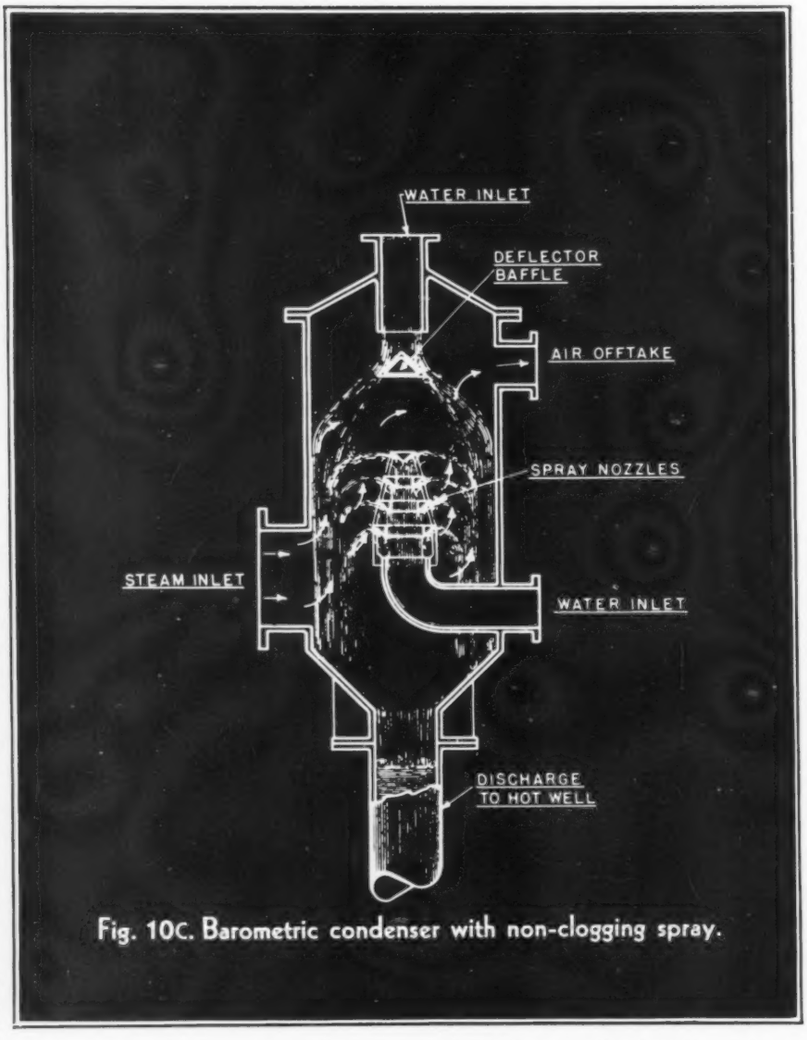

Fig. 10C. Barometric condenser with non-clogging spray.

Southwestern Gas Measurement Short Course April 21-23

The Southwestern Gas Measurement Short Course, sponsored by the School of Natural Gas Engineering, University of Oklahoma, the Corporation Commission of the State of Oklahoma, and the Oklahoma Gas and Electric Utilities Association, will be held this year at the University at Norman on April 21, 22, and 23.

Professors of the university and representatives of manufacturers of gas measurement equipment conduct the short course each year for the benefit of members of the natural gas industry charged with the responsibility of measurement of gas. Classes are open to all measurement men in the industry, as well as engineering students of the university.

A meeting of the general committee will be held in March, at which time final reports will be given and arrangements completed for the 1936 short course. R. D. Turner, Tulsa, is chairman of the general committee; and E. E. Stoval, Dallas, Texas, chairman of the program committee. The subcommittee chairmen are: W. H. Carson, Norman, banquet, entertainment, and general arrangements; Gilbert Estill, Tulsa, exhibits; C. A. Breitung, Ada, registration and publicity; Ray Rountree, Houston, Texas, committee for the study of practical methods, and Max Watson, Amarillo, Texas, publications.

Other members of the 1936 committee are: E. Maurice Myers, Oklahoma City; A. E. Higgins, Dallas, Texas; William F. Lowe, Tulsa; J. H. Satterwhite, Tulsa; W. H. McLaughlin, Tulsa; G. B. Lane, Dallas, Texas; B. P. Stockwell, Oklahoma City; George P. Bunn, Bartlesville; L. G. Rheinberger, Tulsa; V. C. Jarboe, Bartlesville; Earl Knightlinger, Shreveport, Louisiana; R. D. Hanley, Dallas, Texas; Fay C. Walters, Kansas City, Missouri; and G. W. McCullough, Bartlesville, Oklahoma.

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A Hole Full of Records

Union Oil Company's NKO & G Well No. 1, drilled to 10,944 ft. by Ed McAdams as the Lillis-Welsh well, and now greater than 11,000 ft. in depth, has acquired another record—this time for the deepest perforating job ever performed.

By WALLACE A. SAWDON

Petroleum Engineer, Los Angeles

Records Established During the Drilling of Union Oil Company's NKO & G Well No. 1 (Lillis-Welsh)

- Longest string of 8⅝-in. casing: 9081 ft. of 8⅝-in. 36-lb.
- Longest string of 7-in. casing (later removed): 9645 ft. of 7-in. 30-lb. and 36-lb.
- Longest string of 6⅝-in. casing: 10,815 ft. of 6⅝-in. 26-lb.
- Deepest perforation job in the world: Gun-perforated at 10,760 feet.
- Deepest well in Kettleman Hills and second deepest in California: Drilled to a total depth of 11,147 feet.

ALTHOUGH it does not now hold the world's record for depth, this well on the North Dome of Kettleman Hills probably holds the world's record for deep drilling problems. Using no specially designed equipment, the well was taken over by the Union Oil Company for completion when the subsurface conditions in the hole were extremely unfavorable. The results achieved have demonstrated the efficacy of planned, ingenious, and tenacious direction coördinated with intelligent field performance; and have demonstrated that modern drilling is adaptable to meeting the adverse conditions that may arise in the very deep drilling that seems inevitable.

Bits of various kinds were used to meet the drilling conditions encountered. Left to right: Jack Reid, district drilling foreman; Jesse Hughes, tool pusher, and F. F. Hill, director of production

The drilling of this well has for its objective the determination of the northern limit of the commercial productive area of the Kettleman Hills field. The well is in Section 24-21-16, about two miles northwest of the Huffman-Amerada-King area. During the four years it has been drilling the well has been given considerable attention by the oil industry.[1] A brief summary of its history will indicate the difficulties encountered.

The well was spudded in by Ed McAdams for the North Kettleman Oil & Gas Co. as Lillis-Welsh No. 1 on April 12, 1932. A surface string of 18⅝-in. casing was cemented at 1078 ft., and a string of 11¾-in. at 6710 ft. The record string of 7-in. casing was cemented at 9645 ft., after which the well was drilled to 10,944 ft. without unusual difficulty. Coring between 10,917 and 10,921 ft. indicated what was asserted to be the Avenal sandstone, from which was swabbed through tubing a small amount of oil of 35 to 38 deg. A.P.I. gravity.

Upon reaching 10,944 ft. the 3-in. drill pipe stuck and a shot used in an attempt to loosen it exploded prematurely at about 9638 feet. This perforated the casing and let in water.

Only a portion of the pipe was recovered so sidetracking was attempted by redrilling to 9935 ft., and plugging the hole back with cement to 9475 feet. In drilling out the plug, however, a bit and reamer were twisted off. To sidetrack this at 9855 ft. a whipstock was set at 9712 feet; but material in the hole made it necessary to plug back again with cement to 9648 feet.

With the hole in this condition, it was taken over by Union Oil Company as NKO & G Well No. 1 and, under the supervision of F. F. Hill, director of production, resumed drilling on April 11, 1934. Reaching 10,246 ft., an-

Some of the deepest cores taken from the well, which was cored completely from the bottom of the 6⅝-in. string to the final depth—Jesse Hughes, tool pusher, and B. R. Griffith, district petroleum engineer, looking over the cores

[1] "Kettleman Hills Well Now Holds Depth Record," by Wallace A. Sawdon—*The Petroleum Engineer*, May, 1933.
"Union Oil Sets Heaviest String of Casing," *The Petroleum Engineer*, September, 1935.
"The First Two-Mile String of 6⅝-in. Casing," by Wallace A. Sawdon—*The Petroleum Engineer*, January, 1936.

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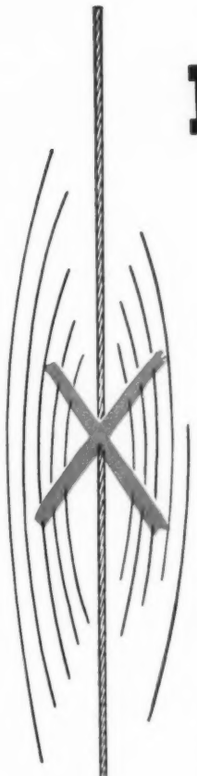

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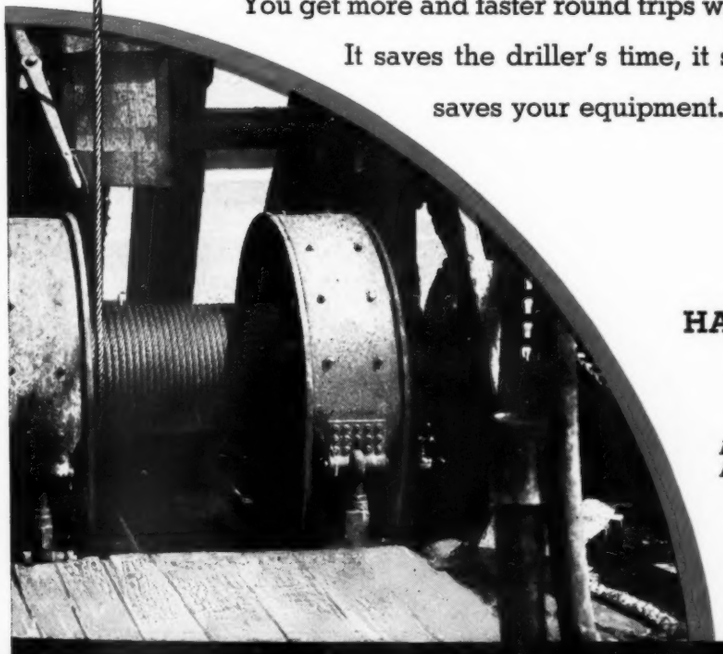

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Looking over some of the core bits used for deep drilling. Left to right: B. R. Griffith, district petroleum engineer; Jesse Hughes, tool pusher; and Jack Reid, district drilling foreman

other twist-off occurred and fishing was unsuccessful. This was then sidetracked and the hole redrilled to 10,234 feet. The presence of old junk, however, made it advisable to put in a cement plug from 9671 to 9588 ft. and begin a new hole.

The 7-in. casing was first cut at 7955 ft. and the string above that point removed. A whipstock was set at 7824 ft. and a new hole drilled to 9065 feet. In pulling out from that point, the drill pipe stuck and a shot run in to loosen it exploded at about 7743 ft., so the hole was plugged back to 7695 feet.

After other twist-offs, plug-backs, and redrilling, a 10⅝-in. hole was finally drilled to 9085 ft. and the record string of 8⅝-in 36-lb. casing was landed and cemented at 9081 feet. This string was picked up, threaded, run, and cemented in 16 hours.

The well was drilled ahead to 9636 ft., when another twist-off occurred at about 9150 feet. Unable to locate the top of the drill pipe, redrilling along the fish was done to provide for its secure cementing in the hole and the well plugged back to 9083 feet. Drilling then continued without trouble to 10,828 feet.

At this depth the world's record string of 6⅝-in. 26-lb. casing was landed and cemented at 10,815 ft., being picked up, threaded, run, and cemented in 15¼ hours.

The hole from the bottom of the 6⅝-in. casing to its present depth of 11,147 ft. was cored continuously with hard-faced core bits; rock bits were used only for cleaning out. Core recovery was practically complete at all times and the Avenal sandstone was found at 10,921 feet. This confirmed the core data obtained when the well was previously drilled to 10,944 feet.

Deepest Perforating Job

Upon a decision to determine what lay behind the 6⅝-in. string of casing cemented at 10,815 ft. gun-perforating equipment was sent to the well. Since the perforator had to be run in under pressure, the lubricator seen in the accompanying illustration and as shown in previously published drawing[2] had to be used. The gun was run to 10,760 ft., where the first shot was fired through the cemented casing at a depth of more than two miles underground. During the first and second series of runs of the perforator 210 shots were made from 10,760 ft. up to 10,589 feet. When the third series of shots was about to be made, a heavy flow of salt water at a temperature of 165 deg. fahr. and a shut-in casinghead pressure of about 300 lb. per sq. in. was encountered. It was therefore decided to shut this water off before completing the perforating.

The well is now cleaning out preparatory to being plugged back to about 10,700 ft. with cement. It is believed this plug will shut off the salt water and facilitate gun-perforating the 6⅝-in. casing for another hundred ft. or so above the present highest shot.

The base of the Temblor in this well was found at about 9650 ft., which is about 1270 ft. above the Avenal. The Temblor was not productive at this location but a little oil was picked up in the Avenal. What the prospects of production are below the Temblor in the present Temblor-producing area of the North Kettleman Dome will probably be determined by some company later.

Regardless of whether or not the Union NKO & G Well No. 1 finds commercial production, it has accomplished its purpose in the determination of subsurface data relative to the northern area of the Kettleman Hills North Dome. In addition, it has demonstrated the ability to meet adverse conditions at great depths; and in so doing has definitely contributed to the science of rotary practice.

It is believed by the company that the constant control of and attention paid to the mud fluid has been a big factor in the success of drilling the well. This company has been doing extensive research on mud-conditioning and has utilized the data obtained by laboratory experiments and field practice in drilling operations on all its wells. The results have aided in drilling and coring under widely varying conditions of pressure and types of formations and in the handling and cementing of casing.

Great credit for the successful drilling of the Union NKO & G Well No. 1 is due to F. F. Hill, director of production; F. Boyd, drilling superintendent; B. R. Griffith, district petroleum engineer; J. E. Reid, district drilling foreman; Jesse Hughes, local drilling foreman; the drilling crews, and to the various departments that have contributed to the operation.

[2] "California Operations Show Advancement in Technical Application," by Wallace A. Sawdon—*The Petroleum Engineer*, Midyear, 1935.

Gun-perforator about to be run into the well through a lubricator for the deepest perforation work ever done

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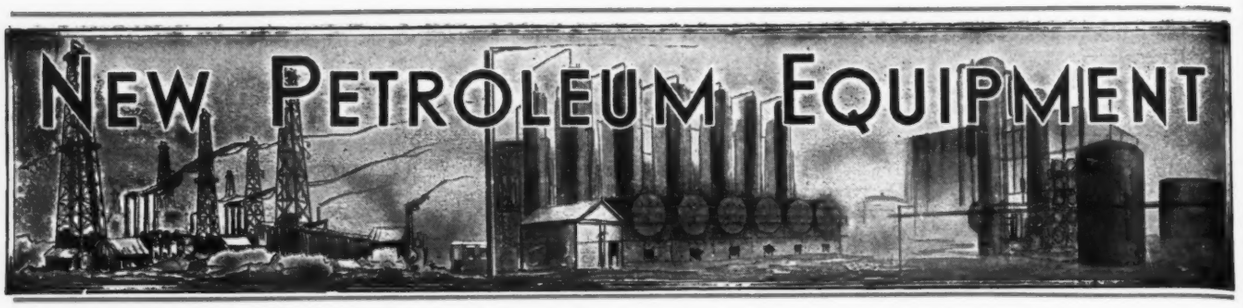


Globe Core Bit for All Formations

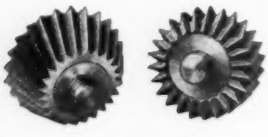
AN INNOVATION in coring equipment is offered by the Globe roller bearing rock coring outfit, which may be used for the hardest formations, but by changing the head takes cores from soft or broken formations.

This outfit is proving popular in fields far from the source of supply, the manufacturers say, since cutters are easily replaceable, the catchers are positive, strong and easily repaired, and the threadless floating inner barrel insures low maintenance costs. The double-duty feature also is worthwhile in many foreign fields where transportation costs are an important item.

These rock core cutters are easily changed, the only tools required being a

wrench, a hammer and a small chisel for cutting off the locking metal on the pin head, it is stated. No welding equipment is used.

Cutters on the Type KR rock core heads are made with right hand spiral, left hand spiral, and straight-cut teeth, and these three types are arranged in each assembled set to attack the formation with a criss-cross, fast cutting action. The deep-cut teeth are sharp and are faced



with fine diamond substitute; reaming edges are accurately ground to gauge.

The soft formation heads, known as Type KS, have positive, cam-actuated dogs in the core catchers, and all parts are easily replaceable.

Complete details, specifications and prices may be had by addressing the manufacturers; Globe Oil Tools Company, Los Nietos (Los Angeles County) California.

Dunn-Lewis Valve of Elliott Core Drilling Company

THE Dunn-Lewis valve of the Elliott Core Drilling Company, manufacturers and Pacific Coast distributors, is a combination positive shut-off gate valve, orifice fitting, and flow bean. The manufacturers claim that no untried engineering or construction principles have been introduced in its design, rather, extreme care has been exercised in combining old and fully proved ideas into one device.

In the full-floating type the seating of the valve is accomplished in the following manner: All plates (1) (see accompanying illustration) are designed with a ring of resilient material (1A), and are inserted between a fixed seat (3) and the seat (2) of the sliding sleeve (7). The sliding sleeve (7) is operated by nuts (9) against flange (8). The method of wedging a disc by stem thrust between two fixed seats has been discarded in the Dunn-Lewis valve.

The non-rigidity, or flexibility, inherent in the construction of the valve permits easy and perfect functioning even under severe line strains due to contraction and expansion, or to lateral deflection, the manufacturers state.

The Dunn-Lewis valve is designed to follow A.S.A. standards, but can be lengthened or shortened in excess of ¼ in. from standard length. This allows adjustment to take up line strains, or for fitting into existing set-ups.

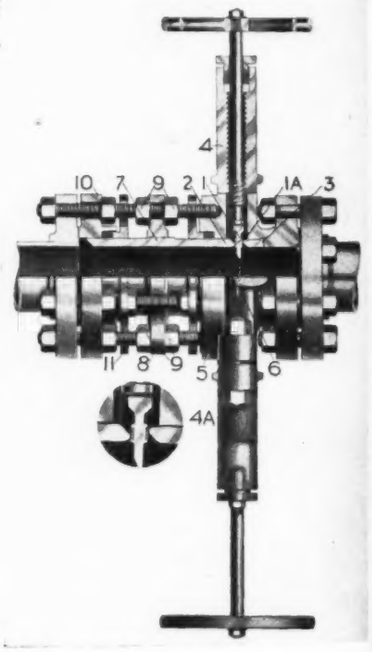
The straight, uninterrupted flow line of the valve readily permits the insertion of special sleeves and body liners to overcome varying corrosive conditions, the makers state.

The valve is designed with two bonnets (4 and 4A), one on each side of the body (5), in each of which can be mounted either an orifice plate or a shut-off plate (1). With either plate clamped between the seats, the opposite plate can be withdrawn completely for inspection or substitution simply by removing the bonnet (4 or 4A) in which it is mounted. A test cock (6) tapped into the interior of the valve body (5) permits the operator to detect the slightest leakage around the seats or between the seats and the orifice, or shut-off plate. An orifice plate, having its opening the same diameter as that of the flow line, permits a smooth, non-eddying full flow and prevents scale or sand settling in the valve. All changes can be made without interrupting the flow through the line.

The semi-floating type differs from the standard type only as to the full-floating sleeve (7). Refer to the accompanying illustration of the standard type and visualize this assembly without the full-floating flange packing gland (11); and fixed to sliding sleeve (7). With this type an expansion joint may be required near the valve, unless bends or other means of expansion are provided.

Dunn-Lewis valves are available in the standard sizes from 2 in. up; in cast iron for working pressures from 125 lb. to 250 lb., and in cast steel for the higher pressures.

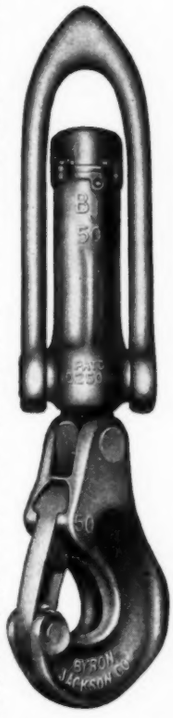
For further particulars, and complete lists of sizes, prices, and weights, address: Elliott Core. Drilling Company, 4731 East 52nd Drive, Los Angeles, California.



Insert shows how the plate is seated

Locking Arm Design Adds Safety to Tubing Hooks

TO MEET the necessity for handling tubing safely, rapidly and economically, several improvements have been made in the design of the BJ tubing hooks manufactured by the Byron Jackson Company, 2150 East Slauson Avenue, Los Angeles, California. By means of a "locking arm," these new hooks eliminate the hazard caused by the flexing of the lower portion of an open end hook that occurs when any weight is being carried, the manufacturers state.



This locking arm is a "built-in" feature of the hook and is not merely added on. When open it extends forward from the bill of the hook member to act as a guide for picking up the elevator links. It then automatically closes and locks as the links seat in the hook and the load is picked up. It then offers a dual safety feature. It joins the bill of the hook to the body and forms a C-link that prevents the repeated flexing that tends to produce metal fatigue and possible crystallization of the lower portion. And it prevents the links from jumping the hook and thus endangering the operator, it is pointed out.

The locking arm mechanism is completely enclosed in the hook. The releasing lever also is enclosed in a recess in the back of the hook at the proper balance point to provide ease in handling. The locking arm cannot open under load,

since, in addition to being latched, the inner end is held down by the elevator links.

The BJ tubing hooks are made in three sizes: the "30," the "50" and the "75." These designations indicate the safe load capacity in tons with a safety factor of three based on the elastic limit of the material. All sizes are equipped with a large ball bearing that acts in conjunction with the trunnion and the main bearing to provide a universal joint action. In the "50" and "75" sizes, a powerful tempered relief spring is entirely enclosed in a heavy housing, and will lift a stand of tubing clear of the collar, thus preventing damage to threads and aiding to speed up operations.

Data sheet showing design and construction as well as full details will be gladly furnished by the manufacturers.

Pipe Insulation for Cold Lines

A NEW type of pipe insulation for cold lines has been announced by Johns-Manville, New York. Known as Rock Cork Pipe Covering, this new product is the same basic material as Rock Cork Sheets. Like the sheet form, the new covering is made of specially waterproofed rock wool, thus being mineral in composition and inherently permanent in character.

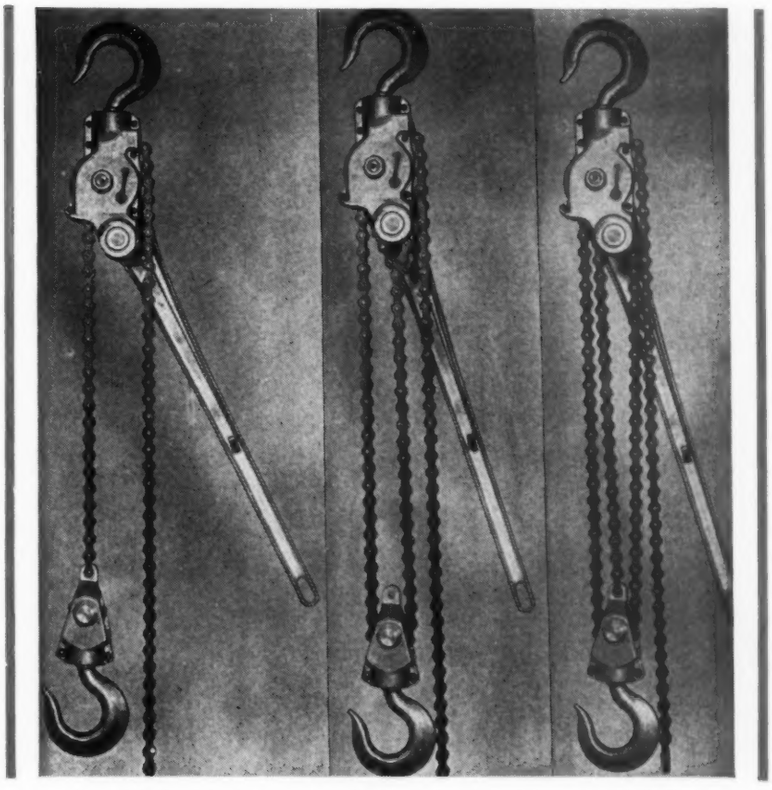
The most important feature of the material, according to the Johns-Manville announcement, is the factory-applied waterproof jacket that provides, in addition to the unusual moisture resistance of the material itself, an absolutely waterproof hermetic seal against the infiltration of moisture-laden air—the most common cause of failure of low temperature insulation.

Fittings are insulated with multiple

layers of Zerotex, a waterproofed rock wool designed for the purpose. Each layer of Zerotex is sealed with a double-wrapping of a special waterproofed sealing tape, and the insulation of the fitting is completed with a layer of an asphalt base plastic.

Claims made for this new covering, Johns-Manville points out, are based on test installations in actual field service during the past four years.

Hoist for Pipe Line Work



2-ton 4-ton 6-ton

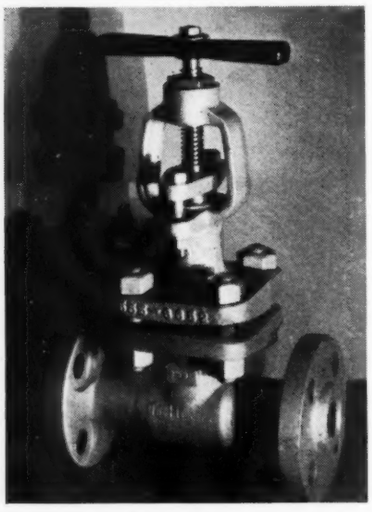
A NEW and powerful hoist has been developed for pipe line work.

It is made to stand the rough usage in the field, and, being very light, it is portable and easy to handle for raising and lowering pipe. It will stand 100 percent overload and each unit can be converted for 2-ton, 4-ton, or 6-ton load by simply changing the chain hook-up.

The hoist was developed by Coffing Hoist Company, Danville, Illinois, for Crutcher-Rolfs-Cummings, Houston, Texas, and is called C-R-C Pipe Line Special.

Hancock Forged Steel Valves

AN improved line of forged steel globe valves has been announced by the Hancock Valve Division of Consolidated Ashcroft Hancock Company, Inc., Bridgeport, Connecticut. These valves are made for pressure ratings up to 1500 lb. and



are specially designed with a tongue-and-groove bolted bonnet for high temperature service.

The new valves are made in either cone or plug type and the valve seat ring and disc are made of heat-treated stainless steel. The makers claim that this trim material is exceptionally hard, and therefore resists wire drawing, indenting, and galling, and reduces repairs.

According to the manufacturer, the features of these Hancock valves include: all parts made of steel for safety against fire hazards; long condensation chamber protects and increases life of packing; all wearing parts are renewable; and that the seat ring is easily removed with a standard hex wrench. The makers further state that these valves are easy to repack in service because of a special stainless steel back seat, and because the gland bolts come completely out allowing ample finger room and because of a relief plug for bleeding condensation chamber while repacking.

The many other distinctive features of these new forged steel valves are fully described in a new illustrated 20-page bulletin obtainable by writing The Hancock Valve Company, Bridgeport, Connecticut.

Air-Operated Indicator-Controller

FOR pressure and temperature control applications not requiring a record of the factor under control, Bailey Meter Company, Cleveland, Ohio, has developed

an indicator-controller that may operate either a diaphragm motor valve or an air-operated control drive. This controller is housed in a 13-in. diameter round casing and may be mounted either flush on a panel or on a wall or column.

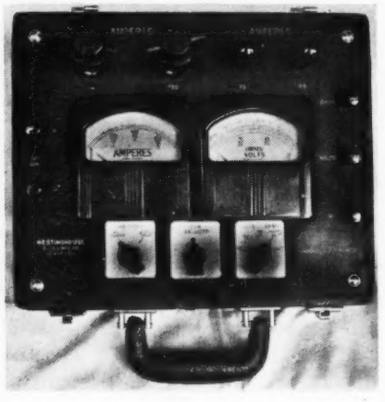
It incorporates an indicating pointer and scale graduated to measure the factor under control. A second pointer indicates the standard for which the controller is set so that the two pointers coincide when the controller is in operation. The standard setting may be changed to any desired point by turning a knurled knob located under the indicating dial. An adjustment also is provided whereby the sensitivity or "control range" may be varied from 1 percent to 1000 percent of the measuring range.

Inside the casing, a Bourdon tube type pressure spring actuates both the indicating pointer and a free floating air pilot valve. Inlet and outlet air pressures to this pilot are indicated by small gauges on either side of the main indicating dial and connections for air supply and control pressure are made through the rear of the casing with ¼-in. O.D. copper tubing.

Compact D-C Industrial Analyzer Cuts Set-up and Testing Time

A RECENTLY developed d-c. test set, for use in making practically any type d-c voltage, current or resistance test with the minimum connections and only one compact self-contained unit, has been announced by Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

This unit indicates the trend toward compact and complete test units, permitting the minimum of overall apparatus,



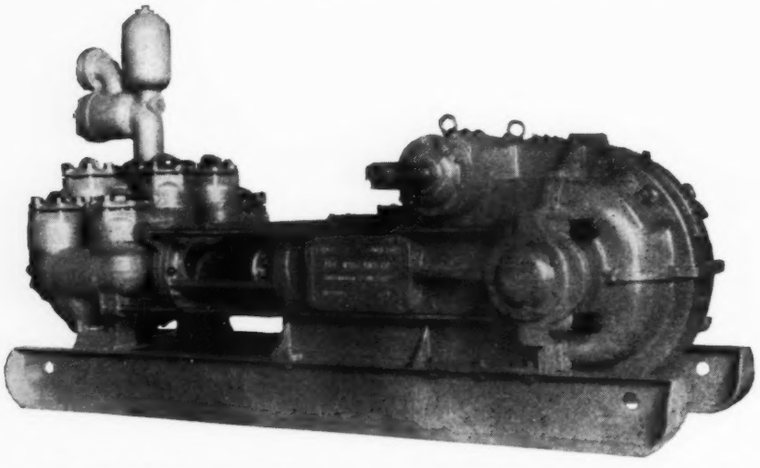
together with the minimum in set-up and testing time, the manufacturers state.

The analyzer is self-contained in a case 8 in. by 11 in. by 13 in. It has two instruments. The ammeter has self-contained shunts for 7½, 75, 750 amperes. The ammeter also can be changed to a 50 millivolt instrument by changing the position of the switch. This permits the use of any range, 50 millivolt external shunt.

The second instrument reads volts and ohms, and there is a switch for changing ranges. The voltage ranges are 150, 300, 750 volts. The ohm ranges are 5 and 500 at center of scale, and ohms can be read from .1 ohm to 20,000 ohms.

The two instruments permit the reading of amperes and volts at the same time.

Power Slush Pump of Wheland Company



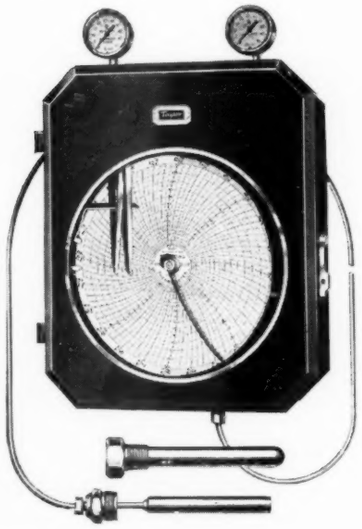
THE Wheland Company of Chattanooga, Tennessee, announces the addition of a new power slush pump to its line. The new pump is type HP-11000 7¼-in by 14-in; and of the same general construction and design as the company's well-known type HP-15000 7¾-in. by 18-in. pump. It has crank type power end, and is completely enclosed, all wearing parts running in oil bath. Pinion and crank shafts are mounted on Timken roller bearings. The water end is recommended for 2000-lb. working pressure. The new pump, along with all other Wheland-Lucey rotary drilling equipment, is distributed by Lucey Products Corporation, Houston Oil Field Material Company, Inc., and Murray-Brooks Hardware Company, and export distribution is through Lucey Export Corporation of New York and London.

Taylor "Thermospeed" Separable Well Tube System

A SEPARABLE well is required on many temperature measurement and control applications to protect the temperature-sensitive bulb from corrosion or erosion, to give it adequate support, or to permit the removal of the bulb at any time without interrupting the processing.

The extra thickness of metal and the inevitable dead air space between the well and bulb always have caused a substantial delay or lag in transmitting a change in temperature to the bulb. On applications having small time lags and heat capacities and where temperatures fluctuate rapidly, this sluggishness of response greatly affects the performance of the instrument.

After months of intensive research on this problem, the Taylor Instrument Companies now claim to have perfected a separable well tube system, known as the "Thermospeed", having a speed response closely approaching that of their extremely fast bare bulb tube systems. Laboratory and field tests indicate that the response due to this new construction is approximately six times faster than the



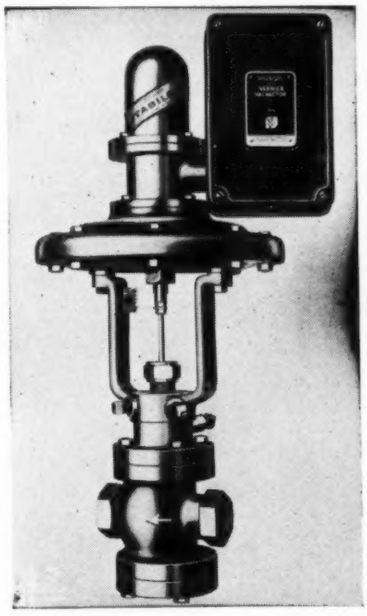
average separable well tube system now in service; and almost twice as fast as separable well thermocouples, the manufacturers state.

The manufacturers look upon the "Thermospeed" construction as the most important advancement in tube system design in recent years, because, they say, it gives speed where it is vitally needed, it means that a dial or recording thermometer so equipped will be extremely accurate in indicating every temperature variation, it assures closer regulation from Taylor controllers because the corrective action of the controllers occurs at the slightest tendency of a departure from the control point.

Write to the Taylor Instrument Companies, Rochester, New York, for complete details.

Foxboro Vernier Valvactor

A NEW accessory for air-operated control valves, the Vernier Valvactor, developed to eliminate valve sticking and to assure hair-line valve positioning, is the latest addition to the line of control instruments manufactured and sold by The Foxboro Company. This device enables throttling type air-operated control



instruments to make small gradual adjustments of the control valve position regardless of friction or hysteresis, the manufacturers state. It is claimed that the air from the control instrument need change as little as ½ in. of water to cause a corrective positioning of the valve and force the stem to take a position within 1/100th in. of the previous one.

In the majority of installations Foxboro control valves will respond proportionately to small change in air pressure without this device, it is said. This is said to be especially true of Stabilflo valves, because of their unique diaphram motor design. The Vernier Valvacator assures exact valve response where the valve stem packing must be very tight to prevent leakage; where the fluids are viscous or contain solids; and friction is otherwise unavoidable or wherever there is danger of valve friction developing, the makers assert. In brief, the Vernier Valvactor gives an added assurance that the valve will not lock itself in one position.

The use of air relay in the Vernier Valvactor imparts fast and positive operation because an ample supply of air is always available.

The unit is mounted in a cast aluminum case, and is completely weatherproof. The case also is available in gas-tight construction properly vented so that the Vernier Valvactor also may be operated indoors on gas supply with the vent piped to a safe spilling point.

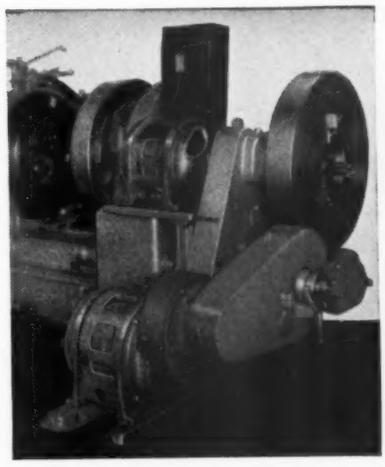
The Vernier Valvactor can be attached directly to the spring housing of all sizes Stabilflo valves. For needle valves and valves without the Stabilflo type motor, the Vernier Valvactor is mounted on the side of the motor supports. It can be installed easily to valves in the field, with but little interruption to service, it is stated.

The Foxboro Company, Foxboro, Massachusetts, will gladly send additional information to any interested person.

Dual Speed Range for Pipe Threading and Cutting Machines for Threading and "Bucking-Up" Tool Joints

THE increased use of tool joints on drill pipe used in the oil fields for drilling has brought about a demand for equipment to pull the joints tight on the drill pipe. For this work, which is generally referred to as "bucking-up" tool joints, a pipe threading machine is usually employed.

The Landis Machine Company of Waynesboro, Pennsylvania, has developed a dual-speed arrangement for their Landis pipe threading and cutting machine with receding chaser die-head, which is said to do this work efficiently. As will be noted from the accompanying illustration, two motors are employed. This machine is regularly equipped with a 1200 r.p.m.



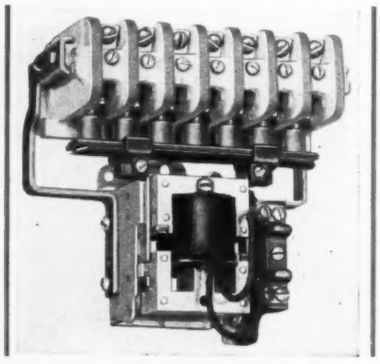
motor that provides spindle speeds through the gear box ranging from 8 to 28 r.p.m. for the thread cutting. The second motor also is a 1200 r.p.m. motor with geared head for 260 r.p.m. to provide a spindle speed of 2 r.p.m. for "bucking-up" tool joints.

For driving the machine at threading speeds a friction clutch is used, whereas a tooth clutch is used for the slow speed. When either motor and its clutch is in operation, the other motor and clutch remain idle. Separate clutch levers are provided on the machine for engaging the proper clutch.

A three-station push button control is employed. One station is used to start the threading motor, the second is used for the slow speed motor, and the third for stopping the machine. The switch is so wired it is impossible to start both motors simultaneously. The slow speed and positive drive provide ample power to insure pulling a tight joint, it is stated.

Multipole Magnetic Contactor

A COMPACT new multipole magnetic contactor, designated as Size O and rated two hp., has been announced by the General Electric Company, Schenectady, New York. It is intended for use either



with small single-phase and polyphase a-c. motors, or as a flexible relaying device for complicated control systems, such as are used on machine tools.

The new contactor is available with either normally open or closed contacts, or with a combination of both. It may be controlled remotely through push-button stations, limit switches, or other pilot devices. Any two forms of the contactor may be combined and mechanically interlocked either vertically or horizontally. A self-contained device, it is easily installed, and can be mounted either as an open-type contactor or as an enclosed switch, for it is also obtainable with enclosing cases. The latter are compact and round-cornered with conveniently located knockouts.

Balloon Wiper Blade for Windshields

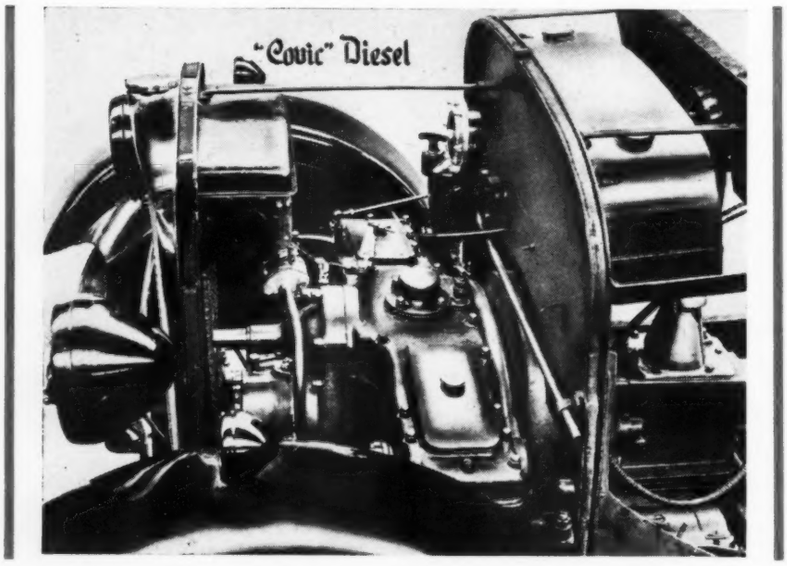
MADE OF soft, carbon-base rubber, with a hollow, perforated tube running its length, the new Rex-Hide Balloon Wiper Blade keeps the auto windshield clean and dry. Ten flexible wiping ribs create alternate areas of pressure and suction with the stroke, drawing water into the hollow tube through the perforations. The self-cleaning operation prevents the same water from being smeared back and forth across the windshield. With its balloon construction, this new blade will hug even a warped glass and wipe it clean, the manufacturers state.

For extreme ice and snow, an ordinary pipe cleaner can be dipped in glycerine, then bent at one end and hung inside the hollow tube of the Rex-Hide blade. This will maintain a glycerine film on the windshield for several hours, remove sleet, and prevent ice from forming on the glass, it is claimed.

All metal parts of the new Rex-Hide Wiper Blade are of stainless steel.

The manufacturer is Rex-Hide, Inc., East Brady, Pennsylvania.

Covic Diesel Engine

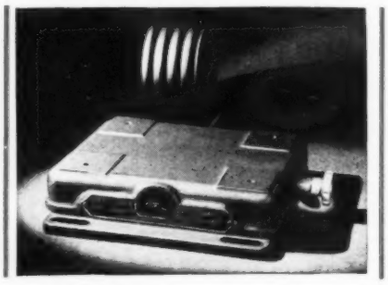


THE Covic Diesel Engine Company, 923 E. San Fernando Road, Burbank, California, announces the acquisition of the sole American manufacturing and distribution rights for the well-known English Victor Horizontally Opposed Diesel Engine, which they shall immediately manufacture and market in the United States under the name of Covic Diesel Engine. This is a small Diesel for vehicle, marine, and stationary use, and is said by the manufacturers to be employed in more than 20 types of applications throughout the world. It is claimed for them that they are ideal units for electric generation and are equipped with either hand control or full automatic. They also are fitted for use with road machinery, hoists, compressors, welders, drag lines, miscellaneous vehicle adaptations, concrete mixers, standby plants, auxiliaries for larger Diesel engines, oil field uses, pumping oil and water, farm lighting, and general industrial portable or stationary work, etc., it is stated.

Straitline Automatic Motor Base

IN offering the motion control vari-pitch texrope sheave recently announced, Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, has not overlooked an important factor in its use and that is the straitline automatic ball bearing motor base illustrated here. It provides a convenient place from which to operate the vari-pitch sheave and maintains a uniform belt tension throughout the speed range adjustment. It eliminates guess work as its dial indicator shows the tension of the V-Belts.

"Placing the Motor on Wheels" is literally what the new straitline automatic ball bearing motor base accomplishes



when used in conjunction with a motion control vari-pitch drive. Four ball bearings, totally enclosed and lubricated for the life of the unit, support the motor and the upper half of the straitline motor base, assuring ease of operation with little or no sliding friction, the manufacturers claim. The travel of the base is in a straight line and is always securely anchored to its foundation.

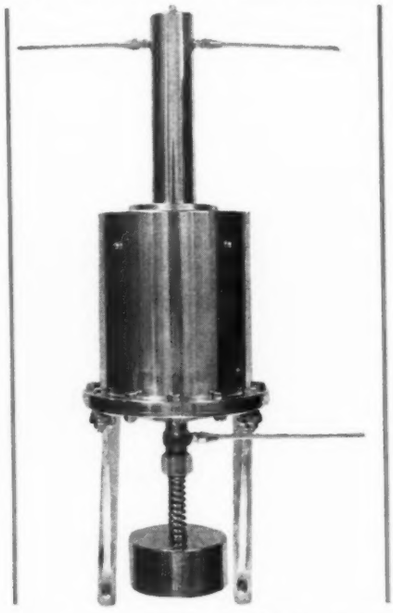
The dial indicator on the straitline automatic ball bearing motor base enables the operator to maintain the correct belt tension at all times, thus assuring maximum belt life. The handweel on the base controls the speed of the vari-pitch sheave and simultaneously moves the motor sufficiently to compensate for the change in centers between shafts resulting from the variation in the diameter of the vari-pitch sheave.

Silvertube Precision Working Barrel

JON R. LONG, Fort Worth, Texas, designer and manufacturer of oil country pumping and production equipment, has developed a new working barrel called the "Silvertube Precision Working Barrel." This equipment is manufactured from a cold drawn seamless steel tube. Tolerances, straightness, and internal finish are of the most exacting precision, according to the manufacturers. The internal finish of the Silvertube Precision Working Barrel is produced by an exclusive drawing process developed by the Detroit Seamless Steel Tubes Company, which closes the grain structure of the steel, leaving a highly-polished, hard, mirror-like surface highly resistant to abrasion and erosion, it is stated. The equipment was designed to increase cup life and give greater barrel efficiency, its makers say.

Rapid Pressure Booster for Testing Gauges, Manifolds, and Pressure Vessels

A HYDRAULIC pressure booster, designed especially for testing gauges, castings, connections, and pressure vessels in the shop or laboratory, has been developed by the Martin-Decker Corporation of Long Beach, California. It requires no special pumps or motors to build up pressures, but is designed to operate from the regular source of water or air supply for the plant.

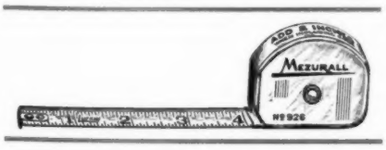


The booster consists of two cylinders, one a low-pressure, into which is connected a line from the plant water or air supply system, and the other a high-pressure, with a lead out to the gauges or lines to be tested.

The booster is mounted on the test bench, or in the most convenient place, with the necessary connections and valves to operate it. By simply manipulating a valve from the plant pressure supply line, pressures can be built up to 5000 lb. at a very slow, steady rate or as rapidly as desired. It is especially useful in testing gauges and manifolds where small volumes and high pressures are required, the manufacturers state. The device is manufactured to provide various capacities and various pressures as required.

"Mezurall," the New Tape-Rule

THE "Mezurall" is an all-purpose 6-ft. steel tape-rule just placed on the market by The Lufkin Rule Company, of Saginaw, Michigan, manufacturers of measuring tapes, rules, and precision tools.



With it, common measuring, either butt end or hook is done in the usual way. To take an inside measurement, one need only butt the square back edge of the case against one side of the opening being measured, extend the blade to the other limit, and add two inches to the reading clearly indicated at the square opening of the case; the case being just two inches wide.

End hook of this tape-rule has short sliding action, so automatically adjusts itself to give accurate results when hooked over any object, (as handy in common measuring), also when blade is projected against any surface, (as in taking an inside or any other butt end measurement).

It carries nicely in the pocket, being small and light weight. Like all other Lufkin tape-rules the steel blade will stand unsupported, like a rule, yet also flex, like a tape.

The "Mezurall" is popular priced and is on sale at hardware and tool stores, mill supply, and engineering supply houses, etc.

Baash-Ross Trubore Drill Collars

THE trade name "Trubore" has been adopted by the Baash-Ross Tool Company, Los Angeles, to designate its rotary drill collars. Years of specialization on the part of this company have resulted in the development and perfection of equipment and methods for drilling the circulation hole straight and centered on the true axis of the drill collar, it is stated.

A number of important advantages are ascribed to the use of drill collars with accurately centered circulation holes. Operators and engineers recognize the value of the improved balance of the drill collar, which results in a smoother rotation of the bit, particularly at the high table speeds now frequently employed, it is pointed out.

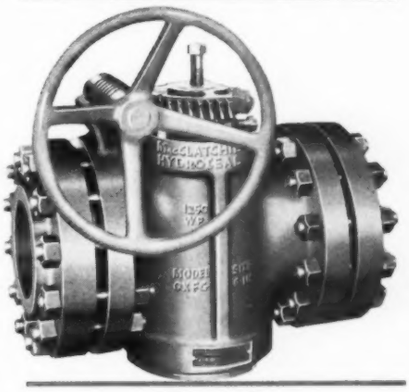
The uniform wall thickness, obtained by accurate drilling of the circulation hole, insures greater strength in the drill collar, the manufacturers state. Off-sets, or enlarged areas in the bore, naturally weaken the member at those points and induce swirling or eddy-currents in the circulating fluid. As there is always a certain amount of sand in the fluid, these uneven areas are often subjected to severe erosion, with consequent further weakening of the drill collar.

A unique and rigid inspection routine is employed by the manufacturers to maintain the quality of this product. A test bar ten feet long and only one-eighth of an inch smaller in diameter than the circulation hole must pass freely through the entire length of the bore before the drill collar is approved.

Trubore drill collars, fully normalized, are stocked in sizes up to 60 ft. in length and in diameters from 2⅞ in. to 8⅝ inches. The manufacturers also are prepared to provide drill collars with extremely large circulation holes to be used with full-hole tool joints.

MacClatchie Hydro-Seal Plug Valves

MACCLATCHIE Manufacturing Company reports a brisk demand for their new "Hydro-Seal" plug valves. Export sales are increasing and there is a good demand for all types, officials of the company state. The valves are made in screw, flange, and union ends, hand or gear operated for working pressures from 250 lb. to 3000 pounds. Because of their grease expanded metal lips no packing nor packing glands are used, thereby eliminating unnecessary friction, the manufacturers state. The photo shows a 6-in. gear operated model—one of a large order recently shipped to the Gulf Coast.



For further information write for the MacClatchie catalog, MacClatchie Manufacturing Company, Compton, California.

Oil-Resisting Pneumatic Hose

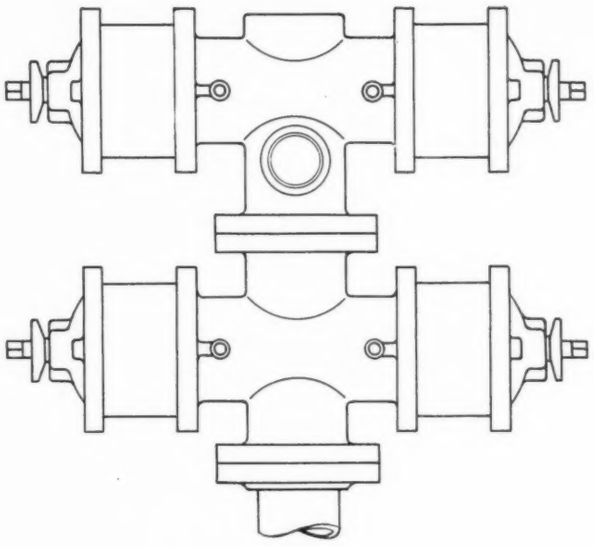
A NEW air hose, designed especially to overcome the deteriorating effects of hot oil from air compressors, is announced by The Republic Rubber Company, Youngstown, Ohio. The tube is made from a compound similar to that used in oil conducting hose and actually can be saturated with oil for long periods of time without affecting its serviceability, the manufacturers state.

In addition, the hose has great resistance to heat, high pressures, abrasion, the cutting effect of sharp rock and exposure to sun and weather, according to the manufacturers, who recommend it where service is exceptionally severe.

Great strength has been obtained, without impairing flexibility, by constructing the plies from a specially twisted cord that is thoroughly impregnated with a new tenacious rubber compound, it is stated. This also increases the bursting and working pressures, and results in greater resistance to shock and abuse, it is claimed.

All construction details of the new hose have been so balanced and engineered as to result in strength without excess bulk or useless weight, it is pointed out.

Figs. 1 and 2



Blow-out Preventer Hook-Ups

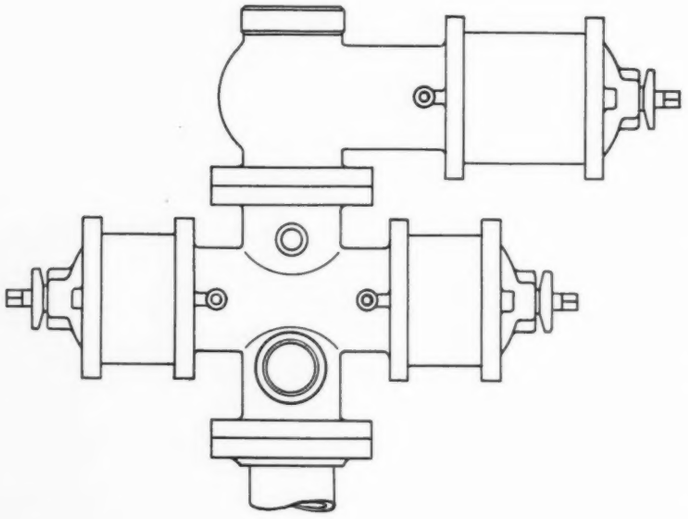
Improved designs permit lubricating drill stem back to bottom with absolute safety in unruly wells

By HERBERT ALLEN[1]

VIRTUALLY all blow-outs, or threats of a blow-out, occur while drill pipe is being pulled from the hole, so it frequently is necessary while coming out of the hole, to close the preventer to retain control of the well. Despite the fact that the bit and much of the drill pipe probably are stopped in open hole below the surface casing, and that the pipe may be from 1000 to 3000 ft. off bottom when the preventer is closed, the only recourse has been mud circulation. To attempt to rotate or raise or lower the drill pipe meant incurring the danger of damage to the sealing means in the blow-out preventer, with subsequent loss of control of the well, loss of the hole, and possible loss of the rig.

Swift and effective subjugation of unruly well pressures often is possible only by building a column of heavy mud from the bottom of the hole to the top. Frequently this is difficult to do, as was illustrated recently on a Goliad County, Texas, wildcat well where the operator successfully got his pipe out of the hole only after 22 hours of constant circulation of the heaviest commercial mud obtainable. Many instances are on record in which circulation was maintained constantly for as long as four or five days.

[1]Chief Engineer, Cameron Iron Works, Houston, Texas.



In the past, means of sealing the annular space between casing and drill pipe have not been designed with full consideration of the obvious desirability of allowing the operator freedom to move his drill pipe. As a consequence, operators usually confined themselves to the use of a single blow-out preventer, for multiple preventer hook-ups provided nothing not provided by a single preventer, except an emergency or stand-by seal in case of failure of the main preventer unit.

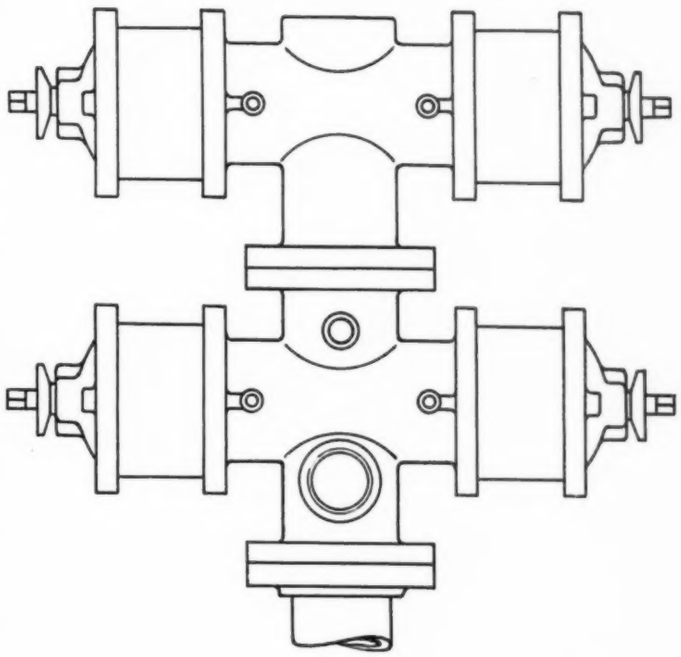
Improved means of sealing recently developed now make it possible, by using two preventers, to lubricate the drill stem back to the bottom of the hole with absolute safety. It will be of interest to examine some of the several types of drilling control hook-ups evolved as a result of this development.

Fig. 1 shows a hook-up consisting of a ram-type preventer made up on the surface casing, the body of which has no flowline outlets and no inlet openings. When the rams of this preventer are closed around the drill pipe, there are no connections below the rams except that attaching the preventer to the casing. Flanged above this lower preventer, which has come to be known as an intermediate preventer, is a standard model ram-type blow-out preventer. This preventer has two flowline openings below the rams, one of which is used to convey drilling mud to the mud ditch, the other is customarily swaged down for connnection of a fill-up line. It is customary practice to install in the flowline two high-pressure valves, one close to the preventer body and one near the edge of the mud ditch. Between these is installed a choke outlet, controlled by a small high-pressure valve. By discharging returns through the choke outlet when circulating to regain control of a well, back pressure may be kept on the well, and complete control retained at all times. All flowline and fill-up line connections are of a test pressure equal to that of the preventer itself.

Operation of the drilling control assembly shown in Fig. 1 is as follows: In the event of a blow-out, rams in the upper preventer are closed; the flowline valves are then closed and the well is under control. Circulation may now be started in an attempt to overcome the formation pressure by increasing the weight of the drilling fluid. While circulation is being maintained, drill pipe may be rotated at any

Fig. 3

Fig. 4



speed between 15 and 30 r.p.m. to keep it free; also, pipe may be raised and lowered slowly through the closed rams of the preventer. If, after a reasonable period of circulation it is found impossible to overcome the well pressure, drill pipe may be lubricated back to bottom by the simple expedient of passing tool joints between the rams, which are alternately opened and closed, of the lower and upper preventers.

With pipe again on bottom, the hydrostatic pressure of the column of drilling fluid quickly may be increased sufficiently to overcome formation pressures, and normal drilling operations resumed without difficulty.

In lubricating the drill pipe to bottom, 95 percent of the wear occasioned by passing drill pipe through the closed sealing means is on the sealing element in the upper preventer. In this manner, the sealing means in the lower preventer is preserved in good condition. Should the sealing means in the upper preventer show signs of wear and leakage, the rams of the lower preventer may be closed and the sealing means of the upper preventer replaced with complete safety.

The lower or intermediate preventer also serves as a master gate on the casing when pipe is in the hole. When its rams are closed around pipe in the hole, the well is shut in and all fittings above the rams may be changed or renewed with complete safety.

Fig. 2 shows a hook-up that provides a mechanical means of completely closing in a well when pipe is out of the hole rather than a specific means for lubricating the drill pipe back to bottom. This hook-up though utilizing essentially the same units as that of hook-up shown in Fig. 1, involves the use of blind rams in the lower preventer that when closed with pipe out of the hole, provide a complete closure of the well bore. It is a positive means of sealing the annular space between casing and drill pipe. Drill pipe may be rotated and raised and lowered between two tool joints, thus obviating sticking while circulating.

Fig. 3 shows a hook-up consisting of a standard model ram-type blow-out preventer flanged to the casing, above which is a flanged gate valve. The preventer has conventional flowline outlets below the rams, and an inlet opening

Fig. 5

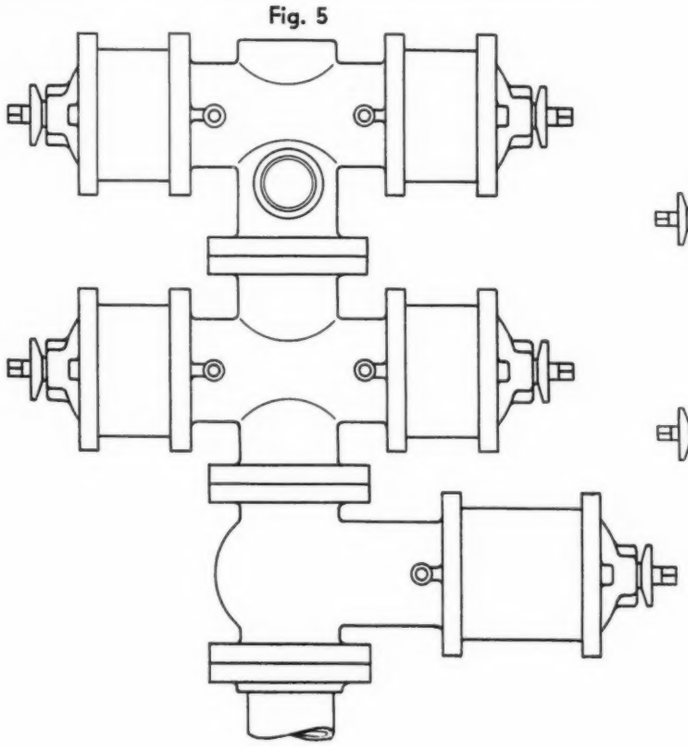
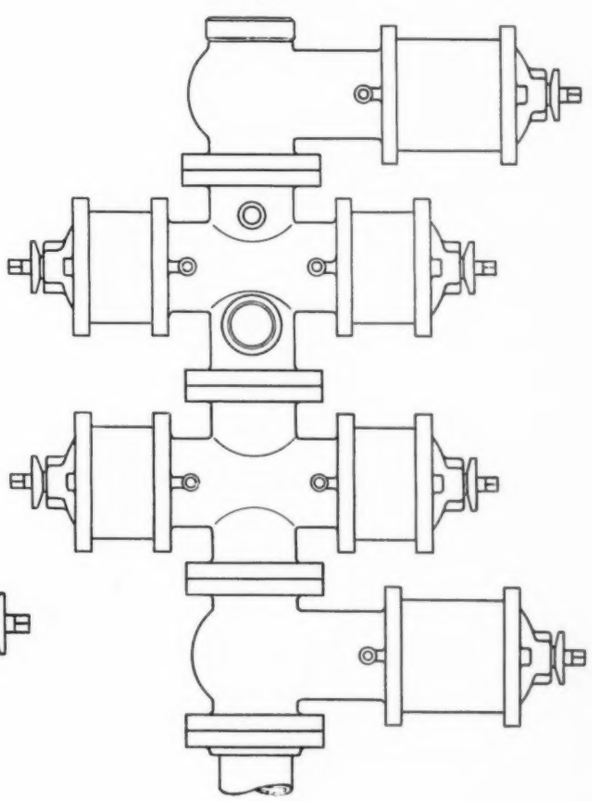
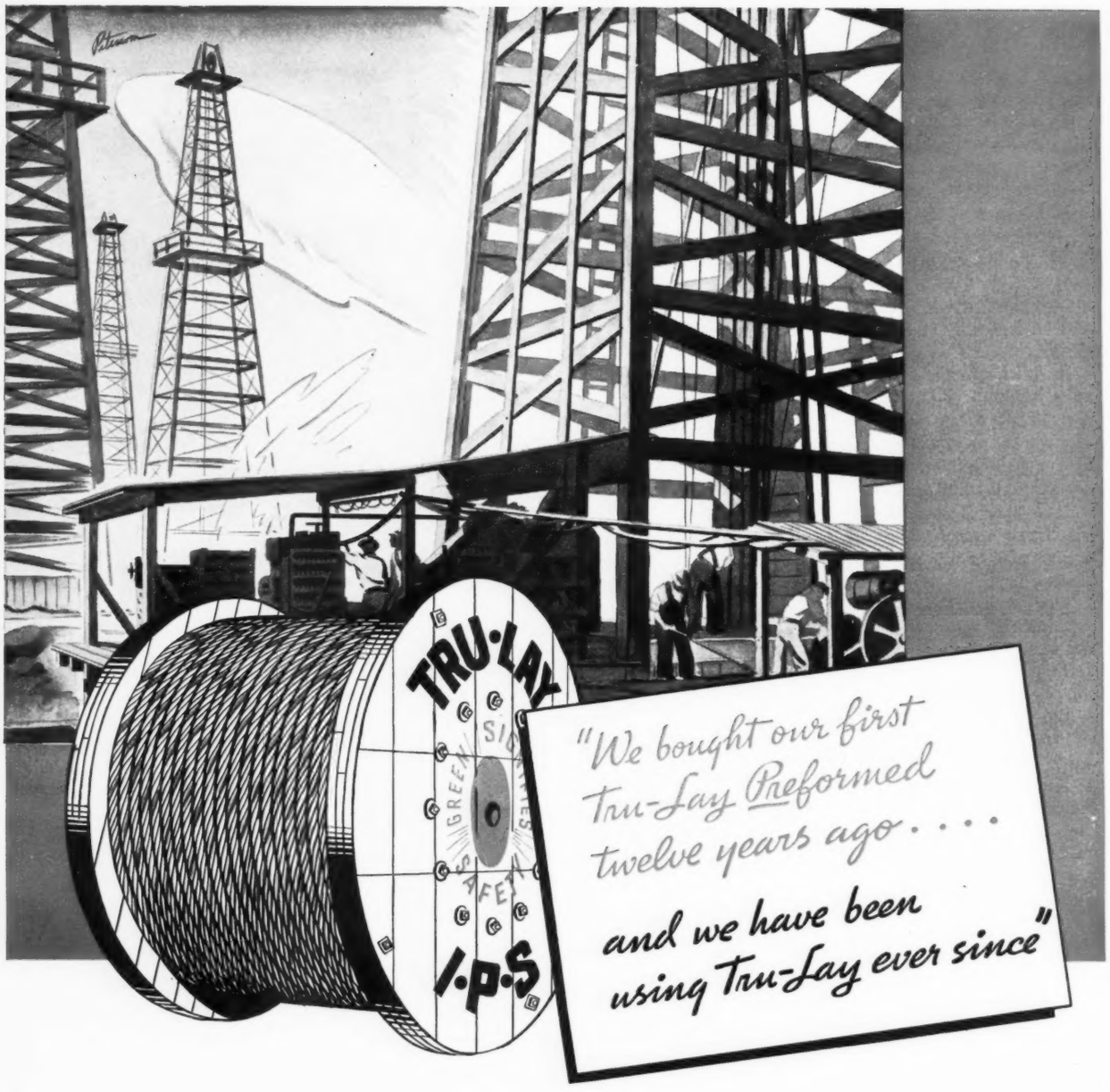


Fig. 6





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for fill-up line above the rams. This hook-up permits sealing off between casing and drill pipe; rotating, raising, and lowering pipe while circulating to kill formation pressure; and, should any fittings from the swivel back to the pumps give way, the drill pipe can be suspended on the preventer rams on a previously loosened tool joint, and the pipe above this joint backed off, pulled out, and the gate valve closed. Circulation can be continued through the fill-up opening above the rams of the preventer, drilling fluid being forced down through drill pipe suspended on the rams.

The hook-up shown in Fig. 4 is a combination of a standard preventer flanged to the casing and an intermediate preventer having blind rams flanged above. This hook-up provides all the flexibility of pipe manipulation permitted by a single preventer, and provides for complete closure of the well bore in case of necessity, or while pipe is out of the hole. Should it be found essential to get back to the bottom of the hole with the drill pipe in order to circulate heavy mud effectively, rams of the lower preventer may be closed while pipe rams are substituted in the upper preventer for the blind rams with which it is equipped normally. With this exchange of rams effected, pipe may be lubricated safely back to bottom and the well promptly brought under control.

Fig. 5 shows a hook-up for high-pressure areas. It consists of a drilling-through valve flanged to the casing, with an intermediate preventer flanged above, and a standard preventer flanged above the intermediate unit. This hook-up permits full movement of the pipe as in the case of the hook-up shown in Fig. 1, and also permits full closure of the well bore when pipe is out of the hole.

Fig. 6 shows a hook-up that provides the ultimate in pressure control during drilling operations. It consists of a drilling-through gate valve flanged to the casing, an intermediate preventer flanged above, a standard preventer above this, and a second drilling-through gate valve surmounting the assembly. With this hook-up the well may be closed in with pipe in the hole by closing the rams of the upper preventer. Drill pipe then may be rotated and spudded through these closed rams while circulating. If necessary the drill pipe may be lubricated back to bottom through the alternately opened and closed rams of the lower and upper preventers. If desired, drill pipe may be suspended on the upper preventer rams on a previously loosened tool joint, and pipe above this joint backed out and pulled up to permit closing the upper gate valve. Circulation then may be maintained by pumping through the fill-up opening in the top preventer, the returns being discharged through a choke opening on the regular flowline. The well may be completely closed in, when pipe is out of the hole, by closing the lower gate valve. This closure is below all other connections. By closing the rams of the lower preventer around drill pipe in the hole, all flow-line and fill-up connections are relieved of pressure, and may be repaired, changed, or replaced.

In conclusion, it is pointed out that recent progress in the design of sealing means of blow-out preventers, and in the assembly of multiple-unit hook-ups, has greatly extended the degree of control attainable over hazardous well pressures during drilling and should aid thereby in reducing the number of disastrous blow-outs involving heavy economic loss.

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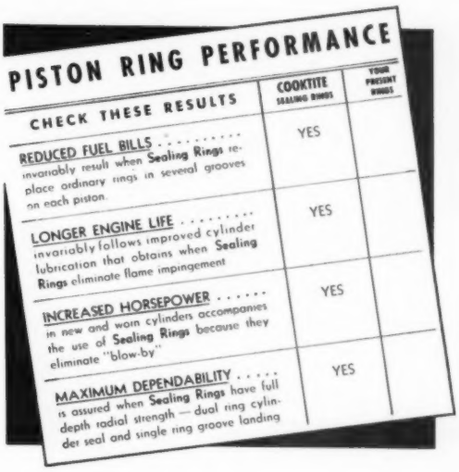
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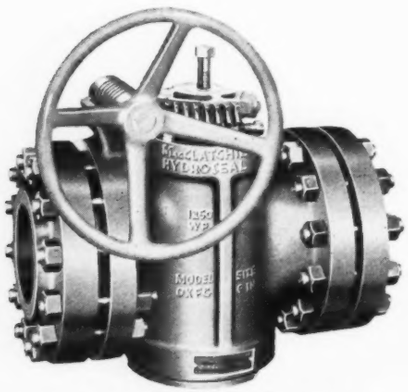

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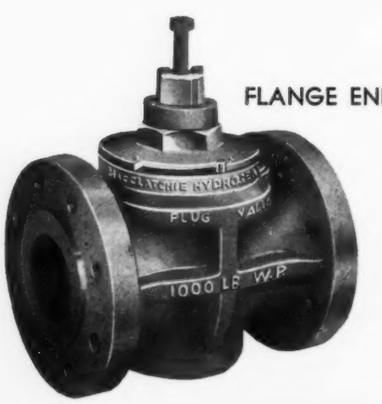
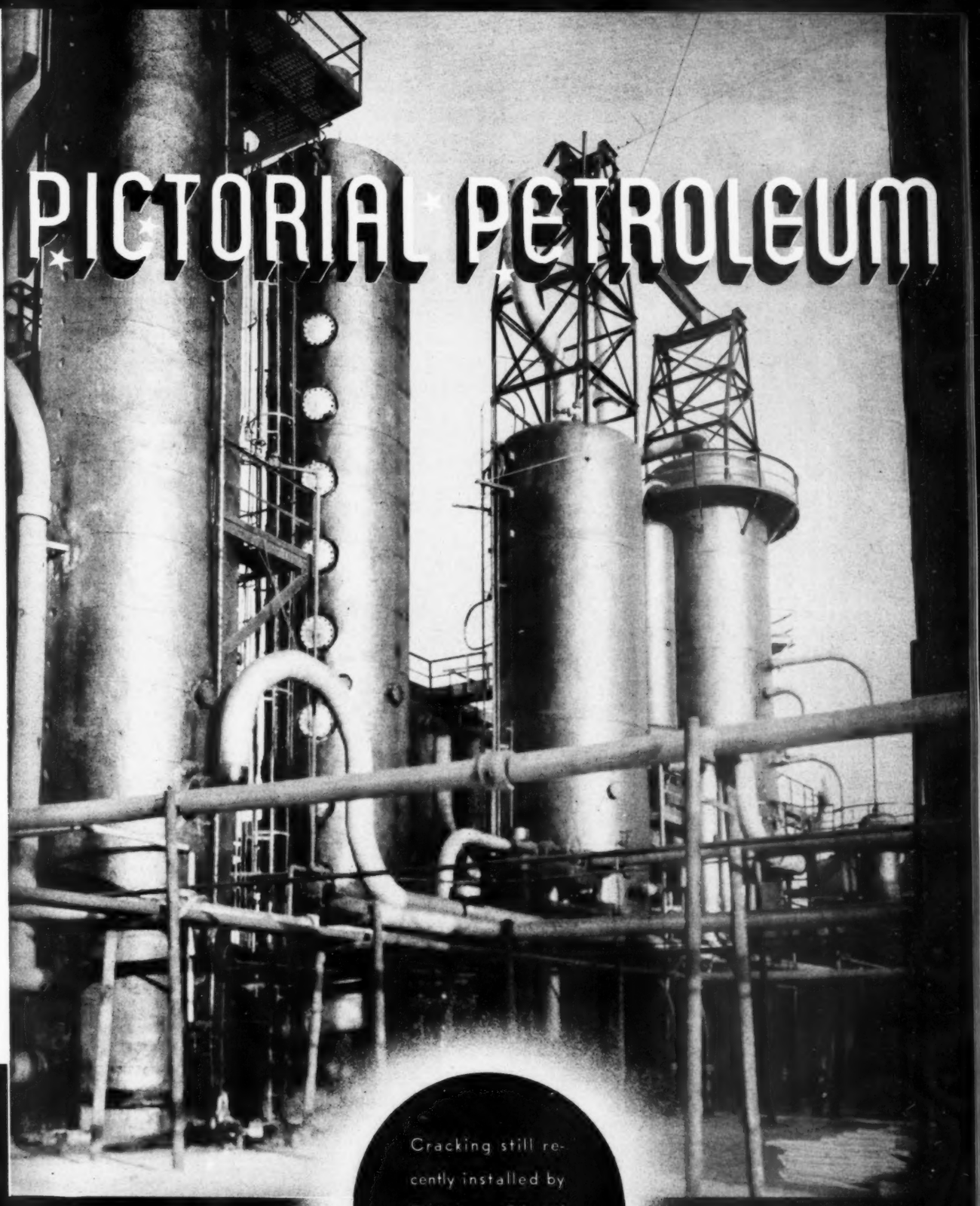


FLANGE END

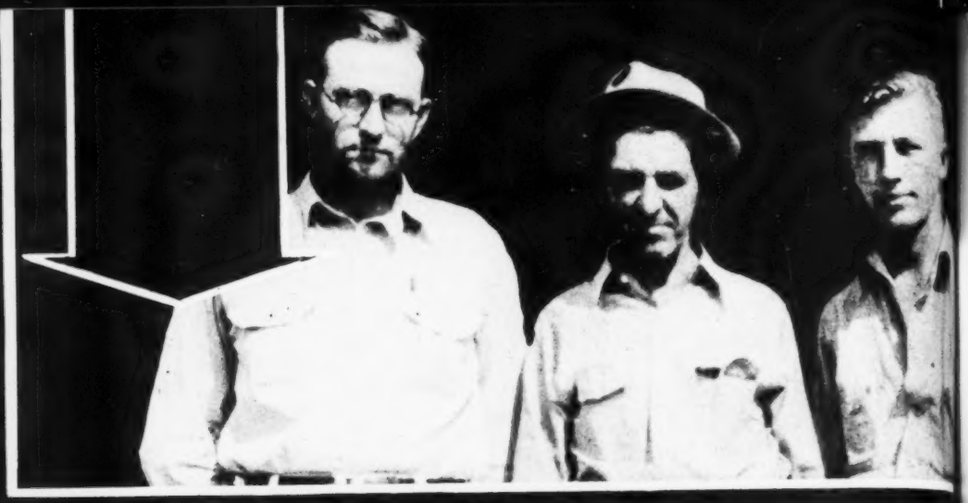
UNION END

PICTORIAL PETROLEUM



Cracking still recently installed by Danciger Oil and Refining Co., Longview, Texas.

MARCH 1936



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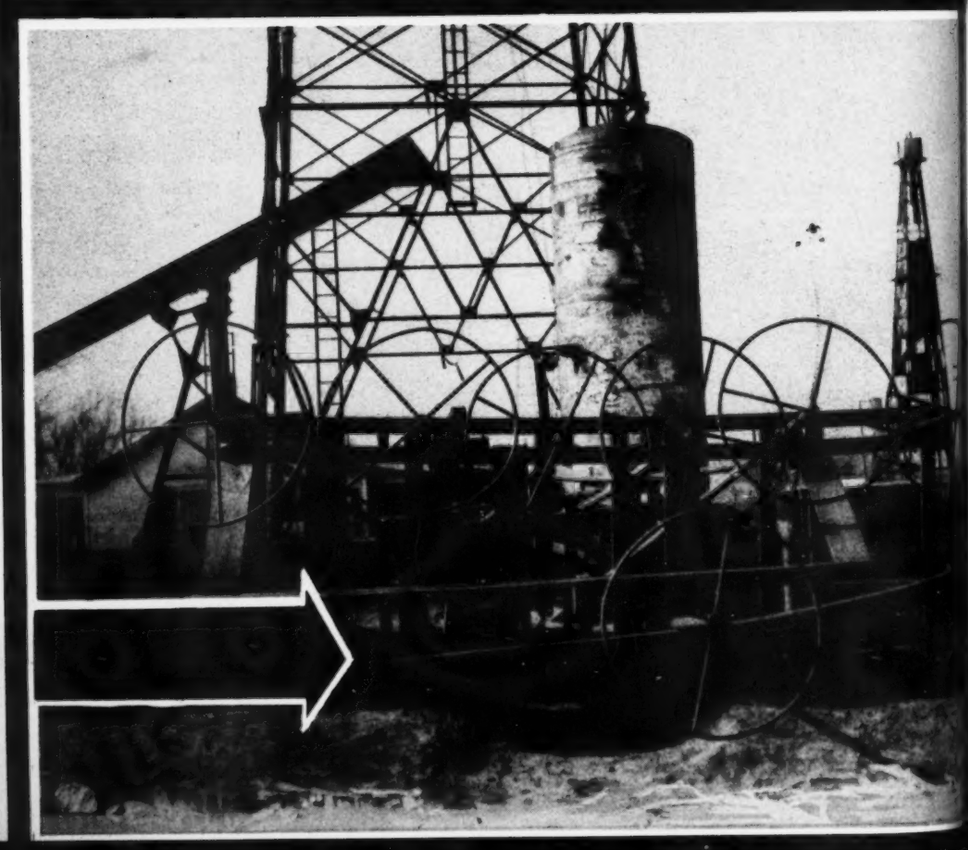

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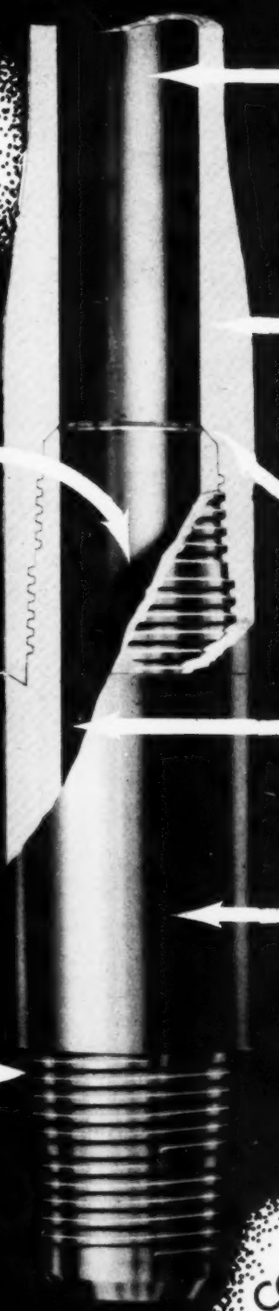

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3 Strong, one-piece tool joint, made of selected steel and heat-treated for maximum strength and long-wearing quality.

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All manufacturers of seamless drill pipe make pipe for the Hydril Internal Flush Joint.

6 EXTRA STRENGTH at the thread in the pipe. Elevator manufacturers make elevators to fit the upset of this joint.

7 This tapered seat insures a tight inside fluid seal, preventing erosion of the joint and threads due to leakage of the drilling fluid under high pressure.

8 No restrictions, off-sets or reliefs in the fluid passage to cause eddy-currents and sand cutting of the pipe or tool joint.

9 The threads are cut in the pipe and the tool joints are made at the Hydril plants at Torrance, California, and Houston, Texas.

See your 1936 COMPOSITE CATALOG or write for complete data concerning this and other Hydril Products.

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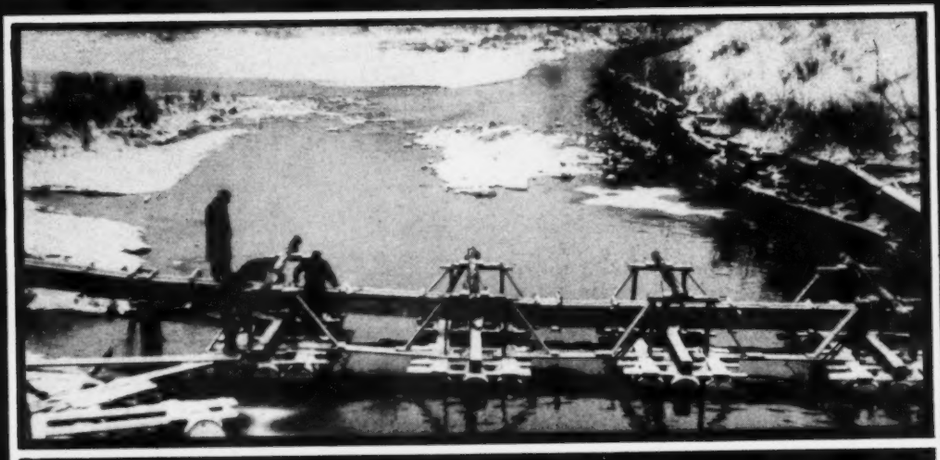

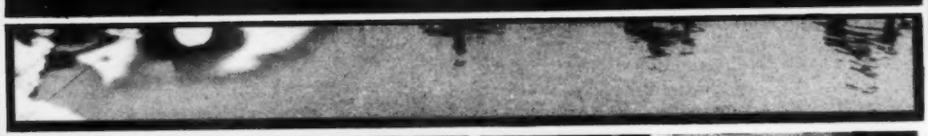

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A case in point is the Continental Oil Company. The record of a Byron Jackson Hot Oil Charging Pump at their Ponca City refinery was the determining factor when the company required another pump for its Denver plant.

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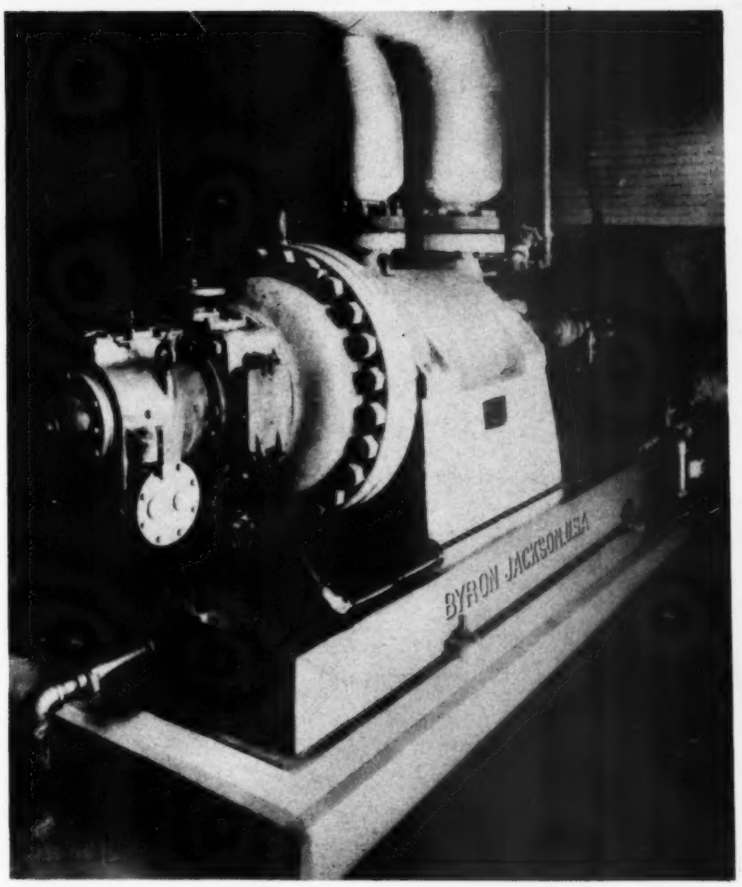

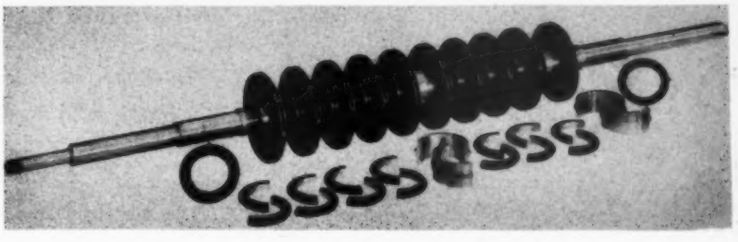

The upper picture shows one of the two 1050-lb., 10-stage, double case Byron Jackson Hot Oil Charging Pumps, operating in the Ponca City plant of the Continental Oil Company. The lower picture shows back-to-back arrangement of the impellers.

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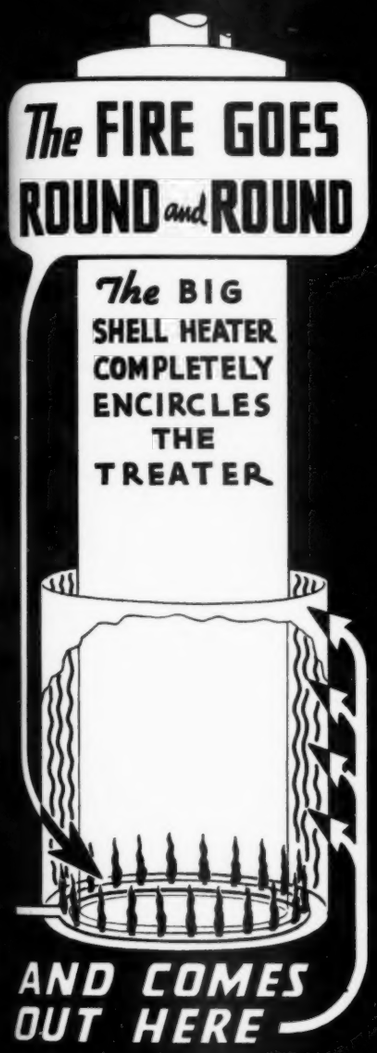

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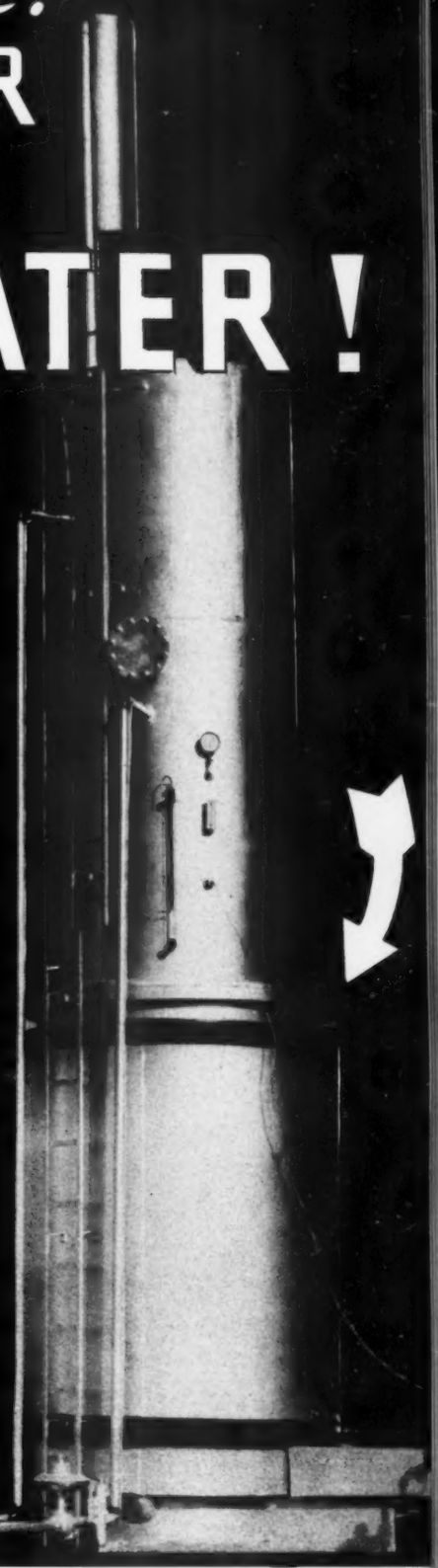

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Underground Trespass in California Oil Fields

Court Accepts Subsurface Surveys of Wells as Irrefutable Evidence Proving Trespass by Unscrupulous Operators

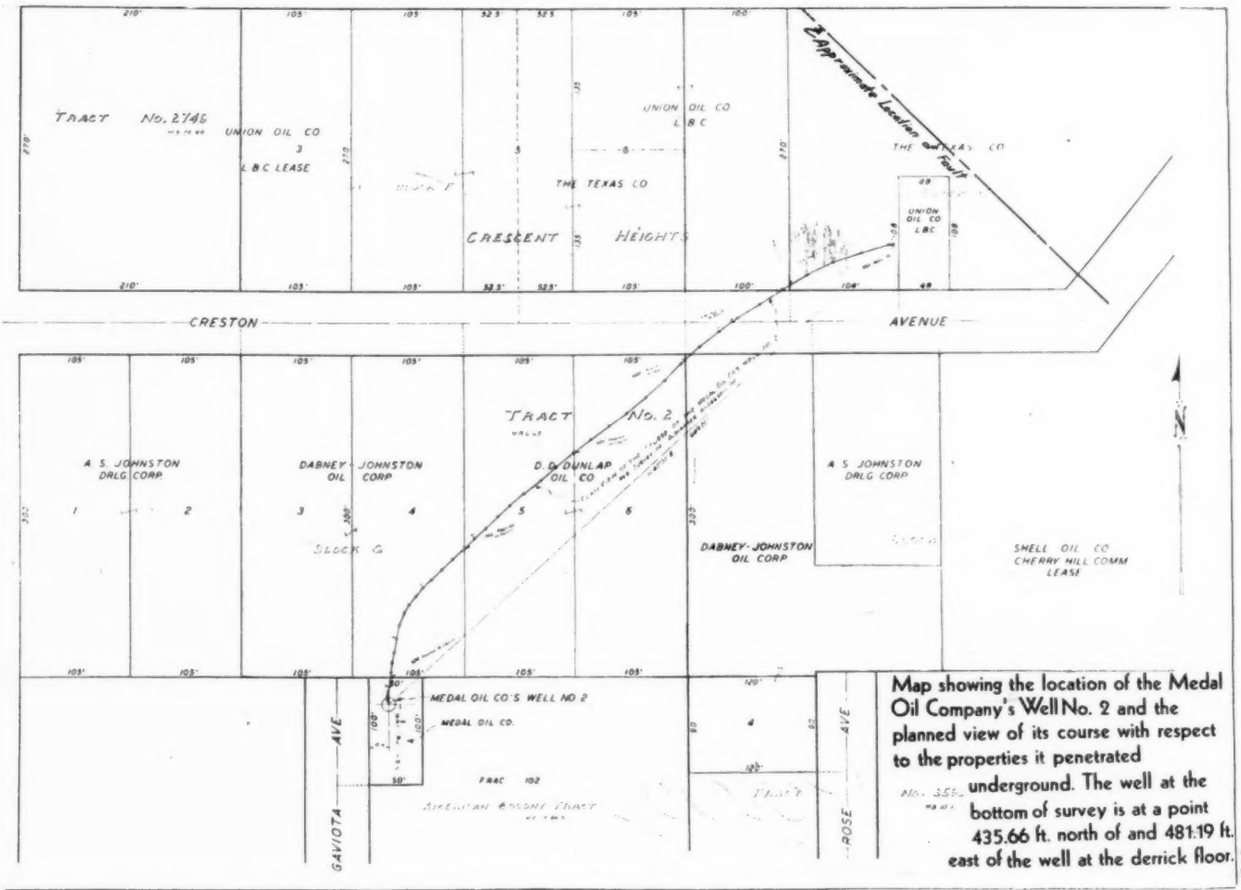
THOUGH controlled directional drilling has become generally accepted as a means of tapping the sand at a predetermined point other than directly below the surface location of a well, its misuse for unlawful purposes has been suffered under protest for the last two or three years. A case recently decided in a trial by jury before Judge Elliott Craig in the Long Beach District of the Superior Court of California in and for the County of Los Angeles, however, has resulted in a decision against trespass below ground that will have far-reaching influence as a deterrent against this practice. The case was that of A. S. Johnson Drilling Company et al, plaintiffs, vs. Medal Oil Company, defendants, and pertained to the Medal Oil Company's well No. 2 in the Signal Hill field, California.

In the Signal Hill field in the latter part of 1934 an unprecedented drilling campaign started in an area that had been considered non-productive. This area lay between Walnut and Cherry Avenues and north of Hill Street. The offending well of the Medal Oil Company, the course of which is shown in the accompanying map, was drilled from one of the most northerly locations in this area. The drilling area extended about 900 ft. south, 300 ft. west, and 700 ft. east of this well. In this space, wells were so close their foundations touched.

Companies owning large leases in the vicinity of this development viewed this sudden activity with alarm. Warning notices were sent out by these companies notifying the operators that they should not permit their wells during the drilling thereof to trespass upon or penetrate within these leases; but drilling continued unabated. The area being drilled was facetiously called by the operators themselves the "hot spot," and within a period of a few months more than 50 wells were completed in a very closely confined area. Many of these wells came in as large producers and continued to produce at a rate that was wholly inconsistent with the surface position of such wells and their location upon the structure.

Efforts on the part of the companies owning larger leases higher on the structure to obtain information from the operators concerning the subsurface position of their wells were for the most part fruitless. It was observed that during the drilling of such wells the operators in every instance used subsurface surveying devices in order to determine the course and direction the wells were taking. In many instances the operators employed deflecting tools such as whipstocks and knuckle joints for controlling the course and direction of the drill hole. In certain instances it was later determined that the operators were so skilled in the art of controlling the direction of drill holes that the use of deflecting tools was unnecessary. The climax was reached when production from the wells in this "hot spot" area mounted to the staggering total of 170,000 bbl. of reported production for the month of May, 1935.

Shortly thereafter the Shell Oil Company, D. D. Dunlap



Map showing the location of the Medal Oil Company's Well No. 2 and the planned view of its course with respect to the properties it penetrated underground. The well at the bottom of survey is at a point 435.66 ft. north of and 481.19 ft. east of the well at the derrick floor.

NO 2

. . . of a Series of Gun-Perforator Applications

CEMENT BLANK LINERS IN NEW WELLS THEN,— Gun-Perforate SELECTIVELY

"PERFORATING PETE" SAYS:

"The time to assure maximum recovery from your well is when the casing is set.

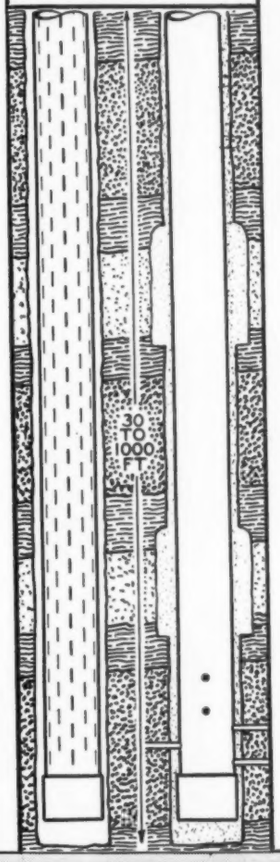
"This means simply to set your casing and cement it solid thruout the entire productive horizon, thus isolating all shales, oil sands and water sands... Incidentally, it's a good thing to under-ream the wet zones and also to wash the face of the formation, when practical, before you pump in your cement; this will give you a better bond... Also, allow as much interval between casing and hole as practical, to make a good thick wall of cement.

"All right, you've now isolated all strata in your producing horizon. The next step is to Gun-Perforate, test and produce each zone that showed possibilities on your coring record—starting with the bottom zone and working up.

"We call this 'SELECTIVE' production, as compared with the old 'scrambled' method of setting hundreds of feet of slotted liner in open hole, then producing several zones of varying pressures and conditions at one time.

"Lane-Wells Gun Perforator Service makes it possible for you to produce 'SELECTIVELY' with safety, because our accurate shooting picks out even the narrowest oil strata without breaking up your cement job and letting in water from adjacent water sands...We've done hundreds of successful jobs of this kind, both in new and re-drilled wells, and where the liners have ranged from 30 to 1000 feet in length."

Diagram at left . . . . shows old "scrambled" method, with screen pipe or liner in open hole. . . . At right, modern "selective" method, blank liner cemented with lower zone Gun-Perforated.



NOTE—Devices used and Method of Operation are fully protected by U. S. Patents No. 1582184 issued April 27, 1926, No. 2029454 issued Feb. 4, 1936, other U. S. and Foreign Patents Pending.

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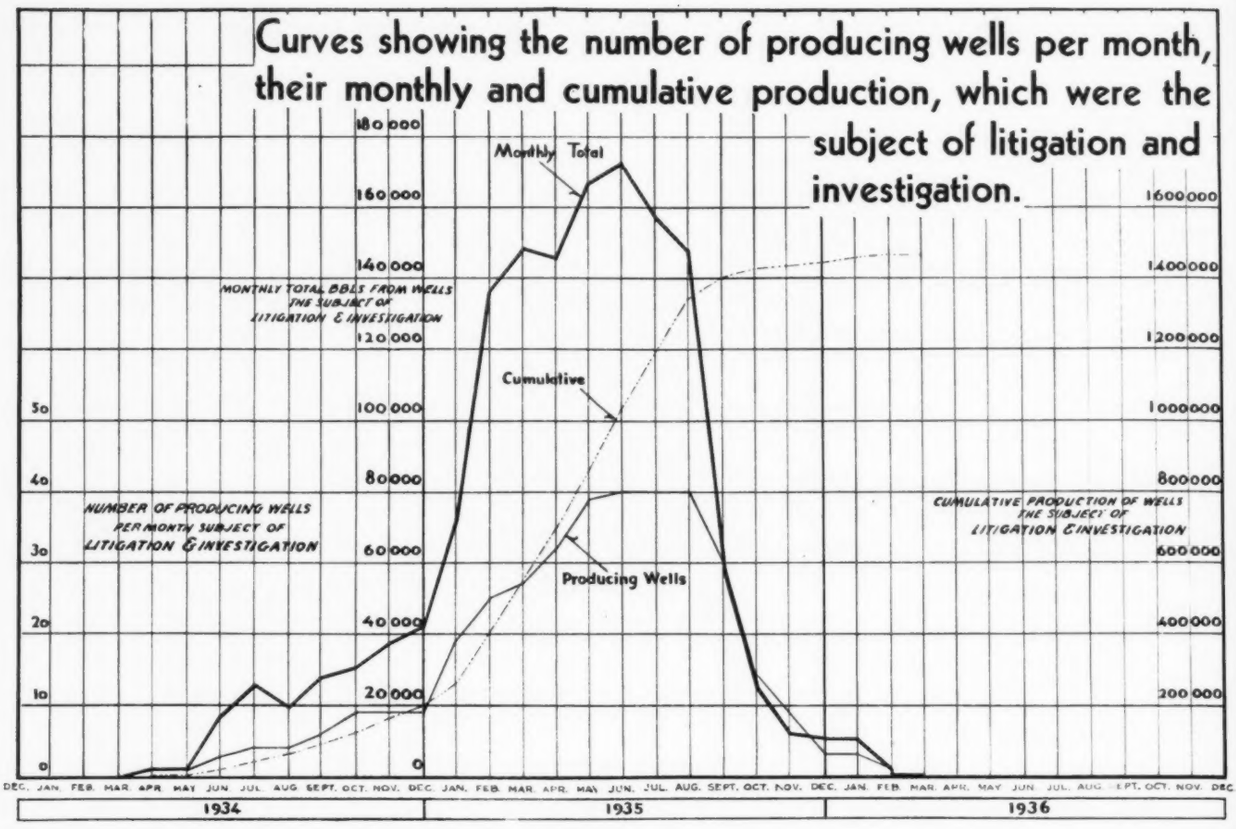

Oil Company, Dabney-Johnston Oil Corporation, Union Oil Company, The Texas Company, and others, all holding large leases up-structure from the "hot spot" area, joined in a series of lawsuits against the operators of these wells and within a short time approximately 40 actions were filed in the Superior Court of Los Angeles County. In these actions the plaintiff oil companies alleged that the particular wells had been intentionally deflected into and within their leases. The first effect of the filing of the lawsuits was the abandonment of a large number of wells by the operators. In many instances the operators, employing great haste in abandoning their wells, left rods and tubing in the hole and filled it full of cement so as to prevent a subsurface survey being made.

Later the Superior Court of Los Angeles County ordered that subsurface surveys be made of these wells and firms engaged in that business were employed for the purpose and the results filed in the records of the Superior Court. The deviations of the various wells extended from 400 to 1200 ft. from the surface locations and in every instance the direction of deviation was up-structure and into the properties of the plaintiffs.

Following the subsurface surveying of the various oil wells the Superior Court of Los Angeles, upon proper application, granted preliminary injunctions restraining any further production from the wells, and from February 1, 1936, no wells remained on production within the area and 30 drilling wells, operating at the time the litigation campaign commenced, have suspended or abandoned drilling operations.

The productive area toward which surveys indicate these Signal Hill wells were deflected (as shown on the accompanying map presented as evidence in the trial) was evidently southwest of the fault shown in its approximate location on the map. The condition that existed during 1934, 1935, and 1936 with relation to wells that it is felt certain have trespassed in this vicinity are shown in the graph. The production curves are plotted from figures obtained from the office of the oil umpire of the State of California. The information is corroborated by subsurface directional surveys in a large number of cases. All the wells included in making the graph are shut in or abandoned at this time.

In the decision on the Medal Oil Company case rendered February 24, 1936, the Court said, "I am satisfied from all the evidence in the case that from the time prior to the commencement of the drilling of Well No. 2, of the Medal Oil Company, that by the use of subsurface surveys, single-shots, and so forth, such as were available, it was possible and reasonable to tell within reasonable distances where the well was going. And I am also satisfied * * * that the deviation of this Medal Oil Company No. 2 well was far, far in excess of what would be a normal or reasonable variation from vertical, were the intention of the drillers to stay as close to vertical as they reasonably could."

The jury found that the Medal Oil Company knowingly and intentionally drilled to penetrate the property of the plaintiffs without knowledge or consent of the plaintiffs; and that it willingly committed trespass. The money received for oil sold from the well was ordered turned over to The Texas Company, upon the property of which the well was bottomed.

The well was surveyed by Alexander Anderson, Inc., to a depth of 3884 feet. The survey was used as evidence and showed that at the depth of 3884 ft., the hole was 435.66 ft. north and 481.19 ft. east of the well location at the surface. The direction at bottom was N. 78 deg. E. with an inclination of 17 deg. from vertical.

In every instance in which the Superior Court ordered a subsurface directional survey of a well the results established the fact that the well was upon and within the property of the plaintiffs in the litigation. The rights of landowners and their lessees to prevent invasion of their lands by trespassing wells have been definitely established.

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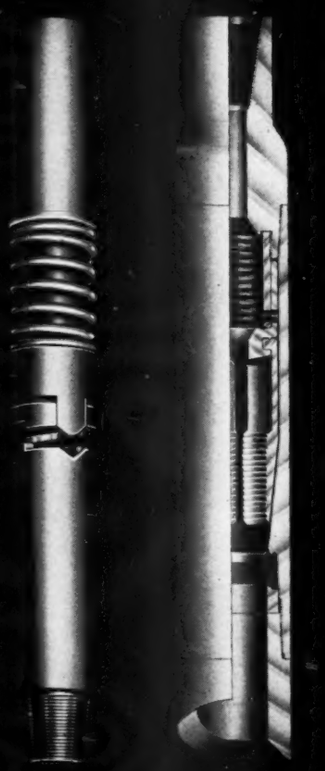

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Refer to Pages 145, 146, 147 and 148 of your 1936 Composite Catalog for sizes and operating details of the tools shown on this page. All other Baash-Ross products are also illustrated and described.

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W. L. NELSON
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Editors

Elements of Applied Petroleum Production

By K. C. SCLATER

Article 29

VACUUM PUMPING

VACUUM pumping is another secondary recovery method for increasing the recovery of oil. In this method vacuum is applied to the annular space between the casing and tubing of pumping wells by a vacuum pump. The casinghead should be air-tight and the casing in the well free from leaks. Due to the vacuum the pressure at the face of the sand is reduced and the oil thereby allowed to flow or be pulled more freely into the hole. Vacuum pumping, like repressuring, increases the differential pressure between the oil sand and the hole. But in vacuum pumping this increase in differential pressure is obtained by reducing the pressure in the hole, while in repressuring the increase in differential pressure is obtained by building up the reservoir pressure. One method pulls and the other pushes the oil toward the hole.

Vacuum pumping is the oldest secondary recovery method in use. At one time it was widely employed. Today, its application is quite limited. The largest immediate returns by employing it accrue from the increase in the gasoline content of the gas. One of the objections to vacuum pumping is that it strips the oil in the sand of its gasoline content. This results eventually in increased pumping difficulties and costs. Only in certain oil properties will the revenue from the increased gasoline content compensate for subsequent losses.

It has been found that vacuum has little practical effect upon the production of oil when the fluid level in the well is maintained above the top of the oil sand.[119]

Compared with repressuring for stimulating production and increasing the ultimate recovery of oil, vacuum pumping has a very limited application. Properties that have been virtually depleted by vacuum pumping over a period of years have been revived by repressuring.

Vacuum pumping may sometimes be employed to advantage by the small operator where his property is surrounded by other properties not operated on a cooperative repressuring basis. In such a case, however, it is pointed out[119] that the possible advantages to the individual operator might be less than if cooperative methods of production were employed.

The effect of vacuum on production depends largely on the texture of the oil sand. In localities where the oil sand is coarse, and offers comparatively little resistance to the flow of oil and gas through it, great increases in ultimate yield have been obtained by vacuum. In other localities where the sand is fine-grained and tight, the resistance offered by it to the flow of oil and gas is too great to be overcome to any appreciable extent by the application of vacuum.[120]

LEASE GATHERING AND STORAGE SYSTEM

Means must be provided on the lease for gathering, gauging, and storing the production from wells.

GATHERING SYSTEM

If development is orderly and well planned, an efficient and uniform system of gathering lines should be designed to fit the ultimate development program. Some companies follow this method and standardize on surface well-flowing equipment.[121] The sizes of gathering lines will be based on the average rates of well production and should be designed so as to impose a minimum back-pressure on the wells. It must be borne in mind in laying out the gathering system that the amount of back-pressure a well can stand without being adversely affected will, like the rate of production, vary throughout the well's life. Lines should be straight, and bends and connections avoided wherever possible.

Unless the topography renders it unnecessary, separators, equipped with vent lines, should be set high to allow the oil to flow by gravity to the gauge tank.

Tankage on the lease usually consists of gauge or flow tanks and lease storage tanks. Production is received from the well separators into the gauge tanks, where the oil is gauged once or oftener daily, thence it goes to the lease storage tanks to wait shipment by pipe line or other means.

The gauge tanks should be of sufficient capacity to permit making an accurate gauge of the well's daily production. They should be set so the top of tank is at the same level as or lower than the well outlet. If the production is high-gravity or gassy oil the gauge tanks should be vapor-tight to prevent loss by evaporation. Steel tanks are in general use, but where corrosion is serious, wooden tanks are preferable.

Modern wooden tanks are designed for the severest field service and are provided with small water courses between the staves so they can be kept moist and protected against drying-out.

On small properties or properties where more than one well's production flows into the gauge tanks, or where each well does not have its own flow tank, provision must be made for testing the wells individually. A test tank of sufficient capacity for one day's or fraction of a day's run of the largest producing well in the group, is set at some convenient point on the lease. All the lines from the well separators are connected into a valve manifold at the test tank. Any well can be switched into the flow tank simply by opening and closing valves in the manifold. A gauging arrangement of this sort is suitable only if the wells produce steadily without much change from day to day. This economical method of gauging may be applied to wells of any size; but one requirement is that the daily production of each well in the group does not vary greatly between tests. Even on the very smallest wells, or those in the stripper class, this same plan of individual testing may be carried out with or without the manifold and with a portable test tank.[122]

A group of small flowing wells whose production is steady may flow into a common separator and a common flow tank, in which case the testing equipment will consist of a valve manifold, a small test separator, and a test tank. By this means individual well tests can be made of both the gas and the oil production.

Meters also are used for measuring well production and obviate the use of gauge tanks. There are several different types on the market, including the displacement type, the gravimetric type, the orifice type, and velocity type.[123] Their use up to the present has been confined principally to the oilfields of California.

LEASE STORAGE TANKS

Lease storage tanks should, if possible, be so placed with respect to the gauge or flow tanks that the oil will flow by gravity. Here again, the topography may govern. It is desirable, if the topography will allow, to have them close together for facility in shipping the oil. The number and capacity of tanks will depend on the lease production and the shipping facilities.

Lease storage tanks should be equipped according to the climate and to the gravity of the oil handled. High-gravity oil and high temperature will mean high evaporation losses unless tanks are properly equipped.

The roof is important in preventing evaporation. It should either be insulated, have a water seal, be vapor-tight, or be of the floating type. Selection of the roof will be governed by local conditions and also considerations of cost.

Vapor-tight tanks must be properly vented by employing relief valves or other means that will allow the tank to breathe with changes of temperature and when filling or emptying and thus protect it from damage. Although authorities do not agree on the details of the mechanism of breathing, there is little difference of opinion on its general features. With a rise in atmospheric temperature the vapors expand and pass out the vent. The liquid surface temperature also increases causing more rapid evaporation into the vapor space. With a drop in temperature, some condensation occurs and the vapors contract, tending to form a partial vacuum and causing fresh air to be drawn through the vents. With the next rise in temperature the air-vapor mixture again expands and the vapor exhaled is lost.[124]

TREATING EMULSIONS

If water accompanies the oil as it comes from the well, there is likely to be an emulsion formed. An emulsion of water and oil usually will require some manner of treatment. The type of treatment will depend on the character of the emulsion and usually consists of heating, or treating with chemicals, or both.

Some emulsions are hard to separate and require drastic treatment. High-voltage electric current is widely employed in treating refractory emulsions.

When emulsions are encountered in producing wells, an effort first should be made to ascertain where and when they are formed. They may be formed in the sand or in the well while the oil is on its way to the surface or they may be formed at the casinghead, in the flow lines, in the separator, or in some part of the gathering system.

Some crude oils are prone to form emulsions when they come in contact with and are agitated in the presence of water. Both the crude oil and the water or brine may contain impurities that aid in forming emulsions. Recognizing these facts, precautions should be taken to reduce agitation of the oil and water in producing operations. Sometimes it is possible to do so by making mechanical changes at or in the well. In gas-lift (artificial) wells that produce water with the oil, for example, the agitation of the oil, gas, and water gas due to high velocities in the flow column or tubing may cause refractory emulsions to form and necessitate a change in the method of production.

In wells that flow naturally and are produced through a flow-bean or choke nipple at the well head, emulsions are commonly formed in passing through the flow bean. Separation of the oil and water under pressure may reduce or eliminate emulsification. For this purpose, flowing wells are usually equipped with some form of water knock-out[125, 126] between the well and the separator. The production from the well flows directly into the water knock-out at the well pressure. There the oil and water are separated automatically and the water drawn off before the oil enters the flow line to separator at reduced pressure.

QUESTIONS

1. What are the limitations of vacuum pumping?
2. In what respect does vacuum pumping differ from repressuring?
3. Under what conditions should vacuum pumping be applied?
4. What constitutes a lease gathering system?
5. What are some of the important factors influencing the design and layout of a lease gathering system?
6. Describe a layout for testing wells individually on a small lease.
7. Explain why vapor-tight tanks must be vented to protect them from damage.
8. Explain the causes leading to the formation of emulsions at or in producing wells.
9. What is the purpose of a water-knockout on a flowing well?

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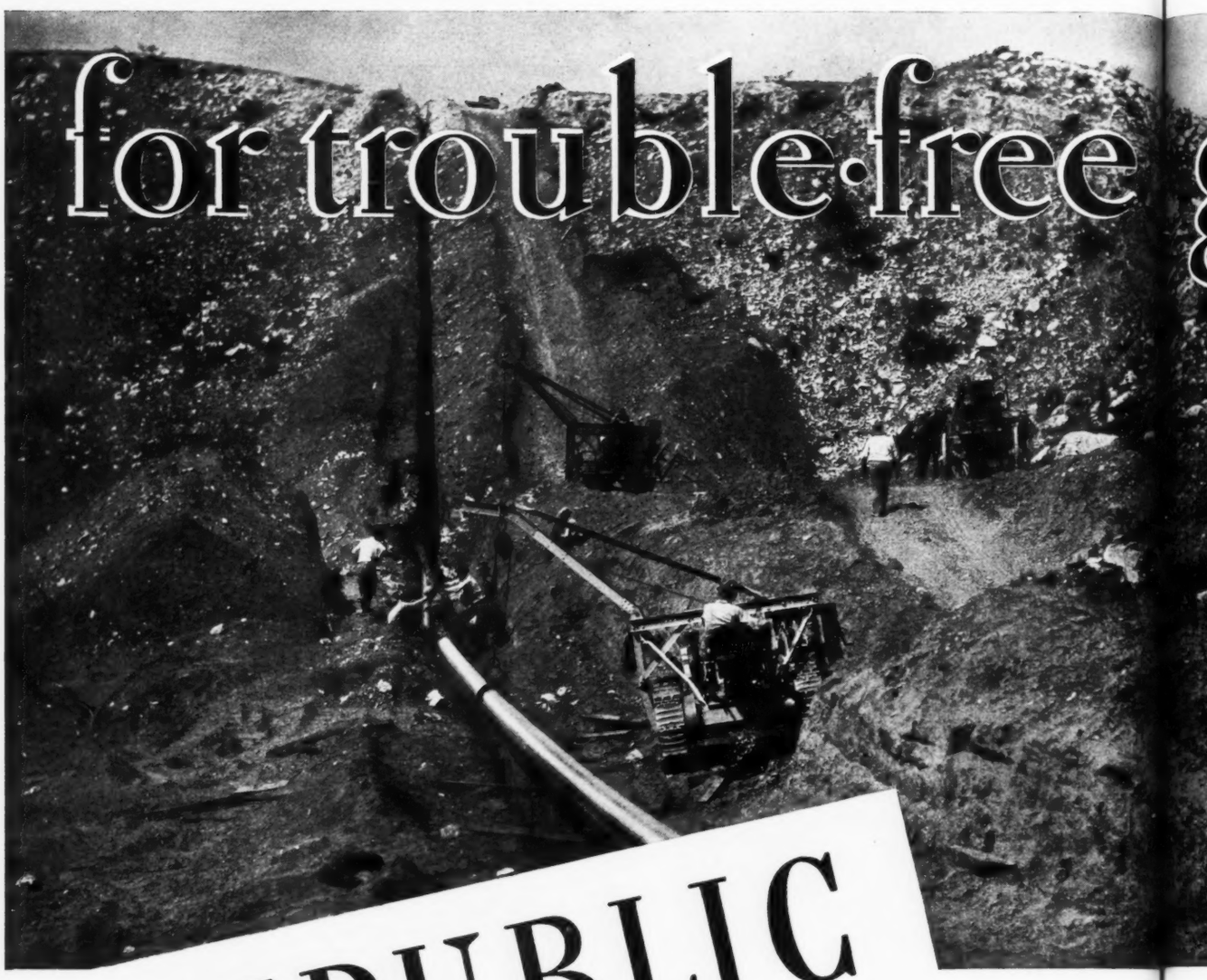

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Elements of Applied Petroleum Refining

By W. L. NELSON, Consultant*

REFINERY PUMPS

Article XXIX

TYPES OF PUMPS

ALL three of the common types of pumps, namely, reciprocating, centrifugal, and rotary pumps are used in petroleum refineries. Each type has characteristics that make it valuable for certain services, and others that limit its usefulness. The reciprocating type operates by taking a charge of liquid into a cylinder through one set of check valves and discharging it by the action of a piston or plunger through another set of valves. The machine is vitally dependent on the valves, and suspended matter may unseat the valves or score the cylinder walls.

The centrifugal type operates by imparting velocity to the fluid. A revolving impeller throws the fluid outward and delivers it to the discharge line. Energy is stored in the fluid in the form of velocity and the kinetic energy of the fluid results in a pressure or head, which is dependent on the velocity and quantity of fluid that is pumped. The pump is particularly suited for low heads or pressures and large volumes. Centrifugal pumps must be primed or filled with fluid before they will function and hence the suction line should preferably be under a slight pressure.

Rotary pumps are of many designs but in most of them a revolving mechanism catches a portion of fluid and delivers it from the suction to the discharge line. Both rotary and reciprocating pumps are displacement types, that is, the fluid must be delivered or the pump must stop. This is not true of the centrifugal pump because the discharge line may be closed and although the pressure increases, the pump simply churns the fluid about in the case.

The common "fittings" for pumps are as follows:

Positive Displacement Pumps

Plain Fitted (abbreviation P.F.)—Bronze-lined liquid cylinders, iron water pistons, steel rods.

Bronze Fitted (abbreviation B.F.)—Same as plain fitted except bronze or bronze-covered piston rods.

Full Bronze Fitted (abbreviation F.B.F.)—All parts exposed to liquid are bronze or bronze-covered.

Centrifugal Pumps

Plain Fitted—Steel shaft, iron impellers, bronze impeller bushing rings.

Bronze Fitted—Bronze or bronze-covered steel shaft. All other parts of bronze except the case.

In addition several special fittings are used, such as: All Iron (A.I.)—All parts of malleable or cast iron except rods or shafts; All Bronze (A.B.)—All parts of bronze except rods or shafts, and Cast-Iron Special Lined (C.I. . . . Fitted)—Cast-Iron cylinders lined with the special material.

RECIPROCATING STEAM PUMPS

The most common pump is the duplex double-acting piston type steam pump. The term "duplex" refers to an arrangement of two liquid cylinders and two steam cylinders that operate so that one piston is at the end-position when the other piston is at half stroke (or at one-fourth of a revolution). The two liquid cylinders discharge into a common discharge line. The term "double-acting" indicates that liquid is discharged on both sides of the piston as it moves back and forth. The term "piston type" means that the fluid is pushed from the cylinder through the valves by means of a piston, whereas in the "plunger type" the liquid is displaced from the cylinder or confined space, by the volume of the plunger as it is inserted. The plunger type may be built with one, two, or three plungers actuated by a common power shaft and the three-plunger type is referred to as a triplex plunger pump. The advantage of the plunger type is that it can be constructed so that the packing about the plunger can be removed or tightened from the outside and thus permit the handling of abrasive-laden fluids that tend rapidly to destroy the packing.

These pumps can be operated on steam, compressed air, or compressed gas. The capacity can be regulated by changing the amount of steam used and the capacity may range from about 10 to 120 percent of the rated capacity while maintaining the rated discharge pressure. They are rigidly constructed and can be moved as a unit unless they are very large; furthermore, repairs are such that they can be made in the plant shop.

The disadvantages of the pump are: (1) the steam consumption is high, (2) to pump abrasive or corrosive materials requires constant repairs, (3) the pulsating flow, particularly at high pressures and high piston speeds, sets up vibrations that cause leaks, break fittings, and ruin control instruments, and (4) the discharge line cannot be closed without producing an excessive pressure.

Customary piston speeds and mechanical efficiencies are shown in Table 46.

TABLE 46

Piston Speeds and Mechanical Efficiencies of Reciprocating Pump

Stroke Inches	Piston Speed—Feet per Minute			Mechanical Efficiency—Percent			
						Pressure Pumps	
	General Service	Boiler Feed and Thick Liquids	Hydraulic Pressure (cold)	Piston Type	Outside Packed Plunger to 300 lb.	to 1000 lb.	above 1000 lb. and Thick Liquids
3	30	16	22	49	47	44	38
4	35	21	26	53	52	49	41
5	40	24	30	59	56	53	46
6	46	27	34	65	61	68	50
8	52	32	40	71	67	63	55
10	60	37	47	76	72	67	58
12	75	42	55	78	74	70	60
15	90	48	62	80	76	73	62
18	100	58	70	82	78	75	64
24	100	65	78	85	81	77	66
36	120	70	88	87	83	79	68

*Professor of Petroleum Refining, University of Tulsa.

The piston speeds for high-pressure hot-oil pumps are even slower than shown in Table 46. They are about half as large as the speeds for hydraulic (cold) pressure pumps. Although reciprocating pumps can be operated at a great range of speed, the higher speeds result in a greatly decreased mechanical efficiency and extensive repairs may be necessary. L. D. Wyant[1] has had a wide practical experience with pumps and he believes that the speeds commonly used are too high. Although the first cost is higher, that is, a larger pump is required, the decreased operating cost including efficiency, repairs, and costly shut-downs will soon justify the higher first cost. He also recommends that the length of stroke should be about 2½ times the diameter of the liquid cylinder unless the pump is very large or very small. Deep stuffing boxes are advisable and the holding or tightening nuts should be readily accessible[1] so that they can be properly tightened without danger to the operator.

The power input to a pump is measured as the Indicated Horsepower (I.H.P.), and it may be computed from the indicator card of the steam cylinder by the following formula:

$$\text{Power input} = \text{I.H.P.} = \frac{P_m L A N}{33{,}000}$$

in which:

P_m = mean effective pressure from the steam indicator card (area of card times spring factor divided by length of card), lb. per sq. inch.
L = length of stroke in ft.
A = area of steam cylinder in sq. in.
N = number of effective strokes per minute.
= r.p.m. for a simple single-acting pump.
= 2 × r.p.m. for a simple double-acting pump.
= 4 × r.p.m. for a duplex double-acting pump.
= 3 × r.p.m. for a triplex plunger pump.

The power delivered by the pump is known as the Fluid Horsepower (F.H.P.).

$$\text{Power output} = \text{F.H.P.} = \frac{G W H}{33{,}000}$$

G = U. S. gal. per min.
W = density in lb. per gal.
H = total head in ft. of fluid

The approximate relation between the capacity, pressures, and diameters of the cylinders for a simplex double-acting steam pump is:

$$D_s = \sqrt{\frac{P_l (D_l)^2}{P_s E_h E_m}} = \sqrt{.41 \frac{P_l}{P_s} \times \frac{Q}{S} \times \frac{100}{E_o}}$$

D_s = diameter of steam cylinder in inches.
D_l = diameter of liquid cylinder in inches.
P_l = discharge pressure minus exhaust pressure in lb. per sq. in.
P_s = steam pressure minus exhaust pressure in lb. per sq. in.
E_o = overall efficiency or $E_v \times E_h \times E_m = E_o$. The subscripts refer to the volumetric, hydraulic, and mechanical efficiencies, percent.
S = piston speed in ft. per min.
Q = capacity in gal. per hour.

The volume of the piston rod is neglected in the formula. In a duplex double-acting pump, two pistons would be moving at a speed of S and hence the equation should be divided by two.

An approximate method of estimating the steam consumption of a pump is based on a consideration of the volume of material pumped. If the steam pressure and the liquid discharge were the same, and there was no loss of power, the pump would use exactly as many cu. ft. of steam as the amount of material discharged, thus:

$$\text{Cu. ft. steam per hr.} = \frac{Q}{7.48} \times \frac{P_l}{P_s} \times \frac{100}{E_o}$$

And by means of the specific volume of steam from the steam tables:

$$\text{Lb. steam per hr.} = \frac{l}{v} \times \frac{Q}{7.48} \times \frac{P_l}{P_s} \times \frac{100}{E_o}$$

This method is not applicable to pumps in which the steam expands.

EXAMPLE 39. *Steam Required for Reciprocating Pumps.*

A steam pump is to discharge 1000 bbl. per day (1750 gal. per hr.) of crude oil at 60 deg. fahr., at a pressure of 300 lb. per sq. in. absolute, by means of saturated steam at 220 lb. per sq. in. absolute. The liquid suction is at 26 lb. absolute and the steam exhausts at 19 lb. absolute. The specific volume of 300 lb. steam is 2.09.

$Q = 1750$
$P_s = 220 - 19 = 201$
$P_l = 300 - 26 = 274$
$v = 2.09$

The overall efficiency is composed of the volumetric, hydraulic, and mechanical efficiencies. These efficiencies cannot be accurately estimated until the size of the pump has been determined. In this case the efficiencies for a pump in good condition will be somewhat as follows:

$E_v = 95$
$E_h = 98$
$E_m = 65$

$$E_o = \frac{95}{100} \times \frac{98}{100} \times 65 = 60.5 \text{ percent.}$$

$$\text{Lb. Steam,} \frac{1750 \times 274 \times 100}{7.48 \times 2.09 \times 201 \times 60.5} = 252 \text{ lb. per hr.}$$

This amount of steam will be used regardless of the kind of pump except that different pumps may have different efficiencies.

QUESTIONS

1. What is meant by the term, "positive displacement"?
2. What materials are used in a Bronze-Fitted centrifugal pump?
3. Explain the terms, double-acting, duplex, and plunger type?
4. What reasons are there for using a long stroke?
5. What three efficiencies are involved in the performance of a pump?
6. A pump that takes suction and exhausts at atmospheric pressure uses 1000 lb. of steam an hour when the steam pressure is 200 lb. gauge and the liquid pressure is 100 lb. gauge. How much steam will be required if the steam pressure is changed to 300 lb. gauge? *Ans.* 667 lb.

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Elements of Applied Petroleum Pipe Line Transportation

By C. E. MAIN, SR.
Engineer, Sinclair-Prairie Pipe Line Company

Article 20

FLOW OF LIQUIDS IN PIPE LINES (Part IX)

THE next step is to determine the elevation of the hydraulic gradient at the gate plants, particularly the gate plant at the end of the divided Section 1-b. This is accomplished by starting at Station B with the elevation of the hydraulic gradient at the receiving manifold, which is assumed to be the same elevation as the oil in the working tank or an elevation of 1015 feet. Since all stations usually run even, with no appreciable flow between the receiving manifold and the working tank to cause a plus or minus gradient, the above assumption is reasonable.

Now going back, or upstream, to the first gate plant, the friction head in Section 3 was found to be 482.0 ft., and when added to the elevation of 1015 ft., we find the elevation of the hydraulic gradient is 1497 ft. for the beginning of Section 3. Next add 1.5 ft. to offset the hydraulic gradient to allow for the loss of head due to the oil flowing through the gate plant fittings. This will give 1498.5 ft. as the elevation of the hydraulic gradient at the end of Section 2.

In the next Section, 2, there is a pipe friction head of 542.9 ft., and when added to 1498.5 ft. gives 2041.4 ft. as the elevation of the hydraulic gradient at the beginning of Section 2. Now add the 1.5 ft. for the gate plant loss and we obtain 2042.9 ft. as the elevation of the hydraulic gradient at the end of the divided Section 1-b.

The pump head in feet of liquid at Station A, for 650 lb. per sq. in., was found by Equation 6 to be 1797 ft., and when added to 875 ft., the elevation of the pressure gauge in the discharge manifold, we have 2672 ft. as the elevation of the hydraulic gradient at Station A.

The difference between the elevation of the hydraulic gradient at Station A of 2672 ft. and the hydraulic gradient at the end of Section 1-b of 2042.9 ft. is 629.1 feet. This is the required sum of the two unknown friction heads h_1 and h_2 for Sections 1-a and 1-b, including the 1.5 ft. offset in the hydraulic gradient for the new gate plant.

In order to compute the lengths in actual miles of both L_1 and L_2 (Fig. 7) or we may say, to divide the length L=15.0 miles (Section 1) into L_1 and L_2 (Sections 1-a and 1-b), we must first know their corresponding slopes S_1 and S_2 in ft. per actual mile. These slopes may be computed by Equation 23 in the following manner:

SECTION 1-a—

We have eight 8-in. lines, and in Equation 23 we may use for the values of N and D, either eight lines 8 in. in diameter, or 2.6444 lines 12 in. in diameter.

With the known values substituted in the equation we have:

$$S_1 = \frac{13186 \times 0.018168 \times 19.44^{0.25} \times 6345^{1.75}}{64.32 \times 12^{4.75} \times 2.6444^{1.75}} = 48.1195 \text{ ft.}$$

the slope in ft. per actual mile for the length L_1 in the divided Section 1-a.

SECTION 1-b—

The nine lines 8 in. in diameter are equivalent to 2.97495 lines 12 in. in diameter, according to Equation 10 (p. 80, August issue) or Table 1 (p. 93, September issue). This table should be used only when the writer's exponents are employed.

When the known values are substituted in the equation we have:

$$S_2 = \frac{13186 \times 0.018168 \times 19.44^{0.25} \times 6345^{1.75}}{64.32 \times 12^{4.75} \times 2.97495^{1.75}} = 39.1565 \text{ ft.}$$

per actual mile for the slope of the hydraulic gradient for the length L_2 in the divided Section 1-b.

We now have:

$$h_1 + h_2 + 1.5 = 629.1$$
$$(h_1 + h_2) = 629.1 - 1.5 = 627.6 \text{ ft.}$$
$$S_1 = 48.1195$$
$$S_2 = 39.1565$$
$$(L_1 + L_2) = L = 15.0$$

which are the four required values necessary to compute the two unknown lengths L_1 and L_2 in the original Section 1.

In the solution of this problem it depends entirely upon whether S_1 is greater or less than S_2, as there are two sets of equations for the solution of such a problem.

Since S_1 is greater than S_2, Equation 21 is selected for the solution of L_1, then:

$$L_1 = \frac{627.6 - 39.1565 \times 15}{48.1195 - 39.1565} = 4.491 \text{ miles}$$

the distance from Station A to the new gate plant, the beginning of the new loop, and

$$L_2 = 15.0 - 4.491 = 10.509 \text{ miles}$$

the required number of miles of new loop to lay for the desired increase in capacity of the station district.

Then for the friction heads, we have:

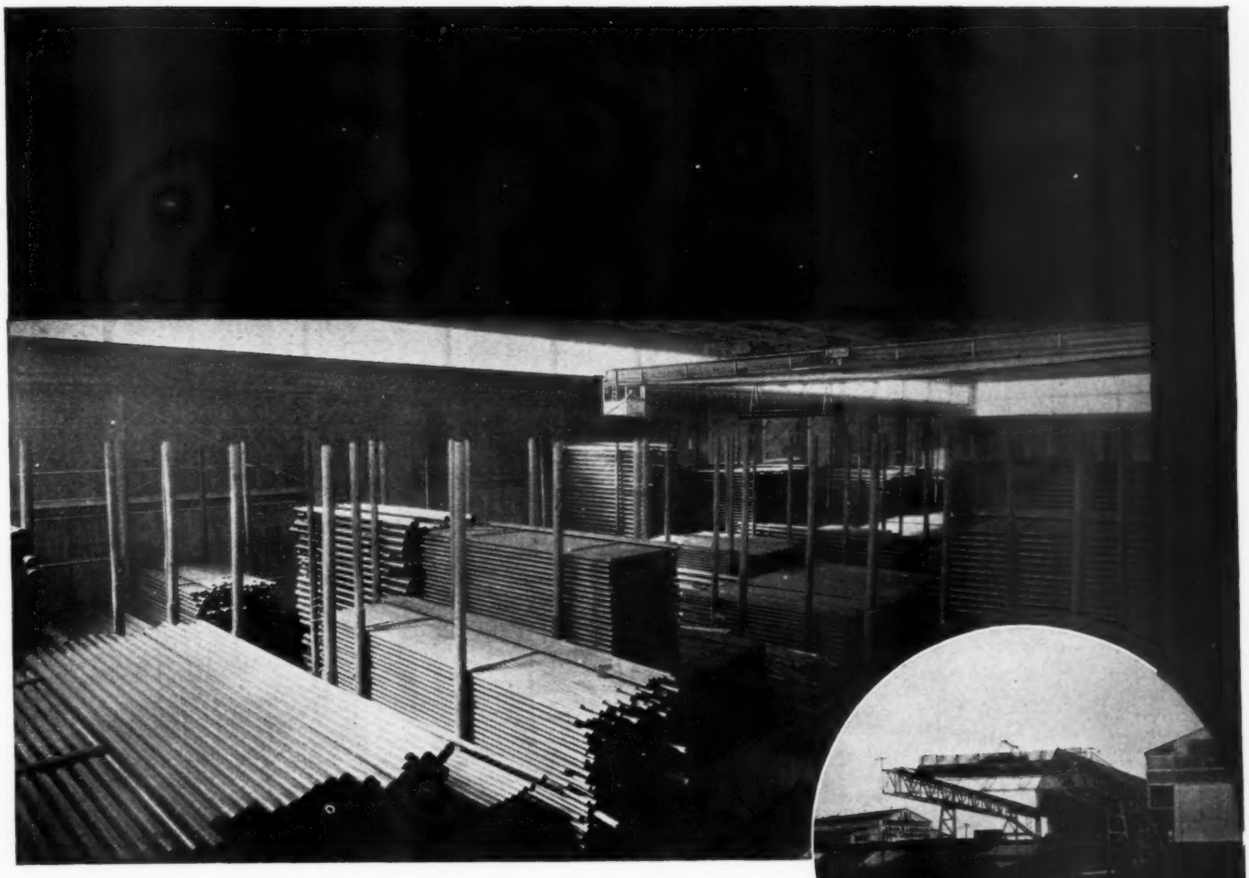
$$h_1 = 4.491 \times 48.1195 = 216.1 \text{ ft.,}$$

and

$$h_2 = 627.6 - 216.1 = 411.5 \text{ ft.}$$

the two required pipe friction heads necessary in order to complete the elevations of the hydraulic gradient that was computed backwards from Station B to the end of the original Section 1, which resulted in the elevation of 2042.9 feet.

In the divided Section 1-b the pipe friction head was computed above as 411.5 ft., and when added to 2042.9 ft., gives 2454.4 ft., the elevation of the hydraulic gradient at the beginning of Section 1-b. Now add the 1.5 ft. for the gate plant loss and we obtain 2455.9 ft. as the elevation of



Left above: Typical J & L Seamless Pipe Stock at Memphis . . . all under cover.

At Right: J & L Warehouse Barge Terminal on the Wolf River, Memphis.

EVERY SIXTH MAN YOUR MAN

Every sixth man in the J & L Seamless Tube Department is engaged in the work of inspection—making sure the product will meet your requirements. Analyzing, checking, verifying are based on your past experience, your present and future needs.

JONES & LAUGHLIN meets your requirements for drill pipe, casing, tubing and line pipe with fast service—complete and dependable. The J & L Warehouse at Memphis carries large and diversified stocks, under cover to preserve their original condition. Users of oil country tubular products in the Mid-Continent, Southwestern and Gulf Coast regions depend on immediate shipments from these extensive stocks at Memphis, or in emergencies your orders can be filled by J & L distributors who maintain large stocks at strategic points in the various fields. Thus, fast and complete service is available, *when and where you want it.* You will profit by using this comprehensive and dependable service.

Other J & L products for the petroleum industry include: steel for derricks and other structural purposes; tinplate for containers; tank barges; and bars, shapes, plates, steel piling, concrete reinforcing bars, wire and nails—for maintenance, construction and repairs.

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AMERICAN IRON AND STEEL WORKS
PITTSBURGH, PENNSYLVANIA.

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J&L PIPE

J&L SEAMLESS

DRILL PIPE · CASING · TUBING · LINE PIPE

the hydraulic gradient at the end of the divided Section 1-a.

The pipe friction head in the divided Section 1-a was computed as 216.1 ft., and when added to 2355.9 ft., gives 2672.0 ft. as the elevation of the hydraulic gradient at the beginning of Section 1-a at Station A.

In order to complete the data for Fig. 6, we still have the equivalent length of one 12-in. line to compute for the divided Sections 1-a and 1-b. By Equation 8 (p. 80, August issue) we have:

SECTION 1-a—

$$M_1 = \frac{4.491}{2.6444^{1.75}} = 0.81897 \text{ miles}$$

SECTION 1-b—

$$M_2 = \frac{10.509}{2.97495^{1.75}} = 1.55945 \text{ miles}$$

and the total equivalent length of the entire station district after the new loop is laid will be

$$0.81897 + 1.55945 + 2.05724 + 1.82679 = 6.26245 \text{ miles.}$$

Before concluding this discussion it may be well to compute the value of the special station district factor E in Equation 22-b for the new layout of the district, after which the discharge will be computed for the total effective pipe friction head. In this instance the total available head of 1657 ft., less 4.5 ft. (3×1.5) equals 1652.5 ft., will be the total effective pipe friction head to use in Equations 22 and 22b.

We have for the value of E (see Equation 22a) for this particular station district:

$$E = \sqrt[1.75]{\frac{64.32 \times 1^{1.75} \times 12^{4.75}}{13186 \times 0.018168 \times 6.26245}} = 140.474$$

from which the discharge B may be computed by Equation 22b for any given pipe friction head h, and viscosity k when expressed in centipoises, that may be desired.

$$B = 140.474 \sqrt[1.75]{\frac{1652.5}{19.44^{0.25}}} = 6345.03$$

bbl. per hour, the same discharge that was used in determining the length of the new loop that created the divided Sections 1-a and 1-b.

Conclusion

To familiarize oneself with the Hagen formula, and the adaptations thereof, would probably result in the adoption of these formulae even though a table of logarithms is necessary, due to the fractional exponents.

The one principal advantage over the Chezy formula is, that in the discharge Equation 22 we have an equation of one unknown, whereas in the Chezy formula, if Equation 15 (p. 91, September issue) is transposed to solve for the discharge, we have two unknowns, since ($f\mu$) varies considerably with the discharge B, and B is unknown.

Another important reason is that either the effective head or the discharge can be directly computed for the entire station district, whereas in the Chezy formula the effective head must be computed independently for each section of the district (in the case of parallel lines) for several discharges. Then the total pump heads obtained therefrom are plotted against their corresponding discharges, and the discharge for the desired pump head is taken from the graph.

In a system of parallel pipe lines composed of several station districts the percentage of error in the computed discharge, when compared to the actual discharge, will be practically the same in each station district after all the lines have been cleaned, but in the case of the Chezy formula, unless the discharge is determined by independent computations upon each section of each station district using only the exponents called for by the friction factors in the equation of pipe diameters, the percentage of error in the computed discharge, compared to the actual discharge of each district, will vary considerably in the several station districts.

The only disadvantage that the writer can recall in the adoption of the Hagen formulae is in the analysis of the experimental data to determine the four unknown values, namely, the roughness factor b, the exponent x of the diameter, the exponent n of the velocity or discharge, and the exponent w of the kinematic viscosity in centipoises. However, this would be possible if there were a sufficient number of experiments available for such an analysis. Such a possibility is not very probable even though we now have several thousand miles of pipe lines in this country upon which such experiments could be made with exacting measurements well within the permissible error for scientific requirements.

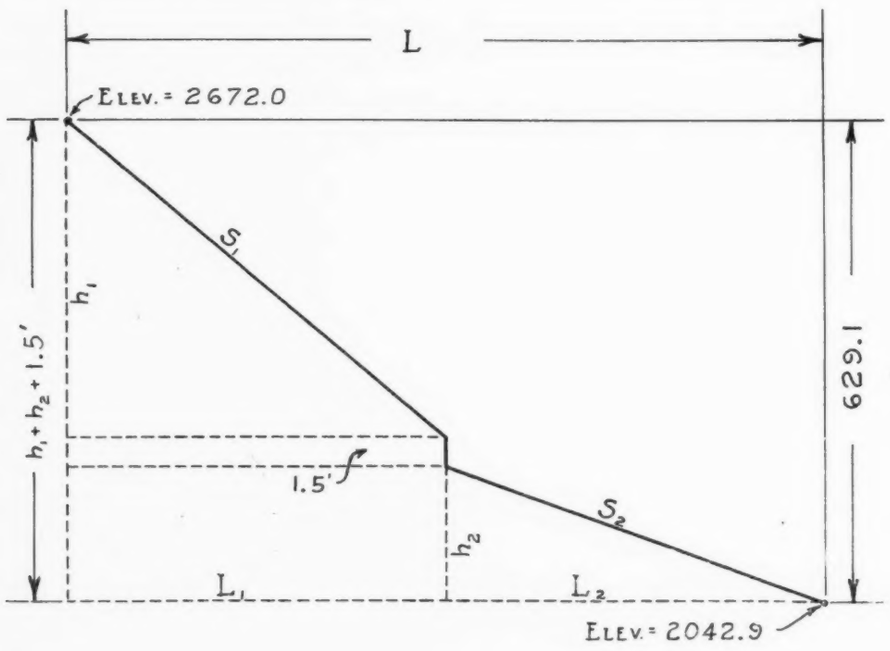


Fig. 7. Chart showing slopes S_1 and S_2, which must be known for computing L_1 and L_2

QUALITY

Fig. 1740
GASO Duplex Piston Pump,
Gasoline Engine Drive
54 to 250 Bbls.

Imagine a scimitar so finely made, so keenly edged, that it cleaves cleanly in two a floating veil of gossamer thinness! Only by concentration upon a single objective, devotion to a single ideal, could such quality be attained.

It is a far cry from the ancient scimitar to the modern oil industry pump. But isn't it logical that the same close application, the same devotion to ideals, should produce pumps that last *longer*, serve *better*, and give *greater* value? . . . . Gaso Pump & Burner Mfg. Co., Tulsa, Okla. Export Office: 149 Broadway, New York.

GASO PUMPS
for every oil industry need

IS THIS plastered mud HOLDING BACK YOUR OIL?

Not Cleaned With a Baker Rotary Wall Scraper. *The coating of rotary mud prevents the free flow of oil out of the sand and into the hole.*

Remove All Rotary Mud With The BAKER ROTARY WALL SCRAPER

Good plastic and wall-forming qualities in rotary mud offer many advantages while you are drilling. But when it comes time to produce your well, that very mud, plastered over the face of the oil sand, often holds back production, clogs your screen pipe and cheats you out of a large share of the production you should get.

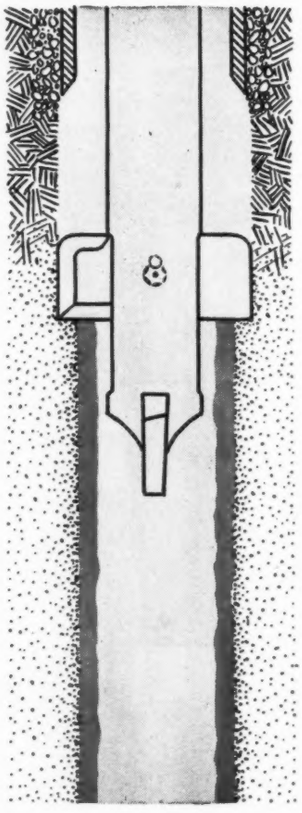
The modern way to assure yourself that your well will be in condition to produce freely is to remove the sheath of rotary mud with a Baker Rotary Wall Scraper—BEFORE PUTTING THE WELL ON PRODUCTION. At the same time you can, if desired, ENLARGE the hole through the oil zone and provide a greater reservoir for the accumulation of oil, and greater clearance for the liner.

The amazing expansion of the blades of the Baker Rotary Wall Scraper enables them to do a thorough job. You can cut to any specified diameter in ¼-inch steps up to the capacity of the size of tool in use. For instance, a No. 3-A Wall Scraper will run in through 6⅝-inch casing and scrape to any desired diameter from 6 to 11 inches.

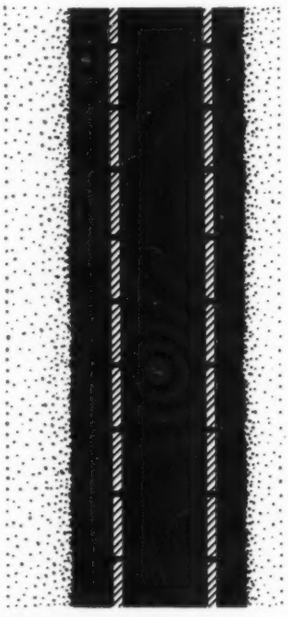
This easy, economical, SAFE method of preparing wells for production has proved so successful that every year more operators, everywhere, are adopting it. Why not try it out yourself?

Always use the BAKER ROTARY WALL SCRAPER to secure these important advantages

- When Underreaming for setting Liners and Casing—allows larger sized liners and casing to be run in easily.
- When Underreaming BEFORE Cementing—gives shoe-point sufficient clearance to permit complete cement distribution and stronger bond with formation, by underreaming last 25 or more feet to bottom; as described above.
- When Correcting Deviations from the Vertical—straightens crooked holes by creating a wide shoulder for NEW start. When Cementing Combination String—enlarges hole opposite section to be cemented—provides excellent condition for successful C. P. job.
- When Cleaning Out Old Wells—enlarges and cleans productive area by wall-scraping to larger diameter.
- When Bottom Water Shut-Off Fails—Wall Scrape to size of original hole or larger (after drilling out old cement)—then re-cement.



This is the way the blades of the Baker Rotary Wall Scraper cut plastered mud from the face of the producing sand and enlarge the hole. Wells that are thoroughly cleaned with the Wall Scraper are put in condition to give a better yield for a longer period because the pores of the sand are opened, and when desired a larger reservoir is provided.



Thoroughly Cleaned with a Baker Rotary Wall Scraper. A CLEAN formation, and LARGE reservoir (when desired) assure the most favorable producing condition.

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BAKER ROTARY WALL SCRAPER

LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

We are indebted to P. V. Kors of the Sinclair Prairie Pipe Line Company, Independence, Kansas, for this one. Says Mr. Kors:

In the early twilight, three storks were discussing the day's activities. First stork remarked that he had a busy day, delivered a pair of twins. Second stork commented that the day had been only fair—that he delivered a baby girl. The third stork said he had nothing to do, so he just flew over a couple of stenographers and gave them a H—— of a scare.

One Way

Wife: You seem disappointed with your package.

Husband: Yes. I answered an advertisement for a device to keep grocery bills down—and the firm sent me a paper weight.

Cad

"Father Time is no gentleman."

"How do you get that way?"

"He tells on women."

A colored man in Texas was enjoying the first watermelon of the season. As the celebrant sat in the back door of the general store working on his third slice, a friend dashed up to him.

"Jim," he gasped, "Jim, dey's bad news for you. Yore wife jest now fell daid frum heart failure!" The husband's cry was an inarticulate gurgle.

"Jim," cried the bearer of ill-tidings, "didn't you heah whut I'm tell you? Yore pore wife jest fell daid. Ain't you got no grief to show?"

The widower raised his head until the lower part of his face temporarily had lost connection with the dripping delicacy. "Boy," he said, "kindly stand 'round yere 'twell I gets th'ough wid dis watermelon an' then I'm goin' to show you some grief."

"Good morning," said the stranger to a woman who had answered the door bell where a room was advertised for rent. "Would you like to buy some insect powder?"

"No," she snapped. "I have no use for that stuff."

"Good," replied the stranger. "I will take that room you are advertising." —*Wall Street Journal.*

Teacher: Now, children, who can tell me how much a pence is worth in American money?"

Jakey: "Vell, teacher, you can get a good pair for three dollars at my fadder's."

So Who Was Drunk?

Gene: I hear you went to a party at Mac's last night."

Cliff: Uh, huh, and ol' Mac drank so much gin we all got worried 'bout him.

Gene: Was he seeing elephants and snakes?

Cliff: No, dat's jus' it—de room was full uv 'em an' he couldn't see any."

The following story is about a certain Scotchman who returned to his native land after a thirty-year absence. Preparatory to his leaving America he wrote and asked his brothers to meet him at the station, and upon his arrival at the home town was met by two bearded men whom he had difficulty in recognizing.

"Why the beards?" he asked. "Dinna ye remember, Donald?" replied they, "You took the razor with you."

No Accident

An Arizona cowboy applied at an army recruiting station for enlistment.

"Ever been sick?" asked the recruiting officer.

"Nope!" answered the cow-puncher.

"Ever have any accidents?" queried the officer.

"Not a one," returned the would-be soldier.

"Then what caused that scar on your hand?" demanded the officer.

"Rattlesnake bit me," laconically answered the cowboy.

"And you don't call that an accident?"

"Nope! The dern son-of-a-gun did it apurpose."—*West Point Pointer.*

Glotz: Pardon me, but is your name Joe Glotz?

Clutz: No, why?

Glotz: Then get out of my topcoat, I'm going home.

—*Indiana Bored Walk.*

He: Where is the best place to hold the world's fair?

Wise Guy: Around the waist.

Story With a Moral

Temperance Lecturer: And in conclusion, my dear fellow citizens, I will give you a practical demonstration of the evils of the Demon Rum.

I have two glasses here on the table: One is filled with water and the other with whiskey. I will now place an angle worm in the glass of water. See how it lives, squirms, vibrates with the very spark of life.

Now I will place a worm in the glass of whiskey. See how it curls up, writhes in agony and then dies.

Now, young man, what moral do you get from this story?

Delt: If you don't want worms, drink whiskey.—*Iowa Frivol.*

A Sure Sign

Proud Parent: My son is home on Christmas leave.

Stooge: How do you know?

P. P.: I haven't had a letter from him in two weeks.

Astronomy

"Which am de most useflest, Ebon, de sun or de moon?"

"Why de moon, ob course."

"How come de moon?"

"Kase de moon, he shine in de night when we need de light, but de sun, he shine in de day when light am ob no consequence."—*West Point Pointer.*

"I'd ask you for this dance, but all the cars are occupied."

—*Penn Punch Bowl.*

At one of the relief agencies in a not-distant oil center, a society girl was employed as clerk to interview the applicants. One man asked for groceries for his family and feed for his stock, saying:

"The weather has turned cold and I have got to have some shorts for my pigs."

The girl listened and then replied: "Yes, and if I let you have the shorts for the pigs you will come back next week for some step-ins for your cows."

—*Tulsa World.*

A man of six feet eight inches applied for a job as a life guard.

"Can you swim?" asked the official.

"No, but I can wade to beat the devil."

A. R. WILSON, division manager of the production department of The Texas Company, with headquarters at Denver, Colorado, has been made assistant to the manager of the production department with headquarters at Houston, Texas. **H. A. STEWART,** formerly in charge of the geological and land department of the Rocky Mountain Division, becomes assistant division manager in charge and assumes active management of that division. **F. H. GOWER** heads the land and lease department under the new management, and **H. E. HUNT** the geological department of the division. **M. J. HEALD** has been transferred from West Texas and made division superintendent. All have headquarters at Denver.

J. F. CONWAY, assistant general manager of the Standard Oil Company of Argentina, visited California recently.

NIELS MATHESON has resigned his position as field manager of the British Controlled Oilfields, Ltd., in the El Mene field of Venezuela to return, with Mrs. Matheson, to their home in England.

D. A. DETTER, F. B. KNOX, and **C. R. CUNNINGHAM,** members of the field staff of the Caribbean Petroleum Company in Venezuela, have returned to their posts following vacations in the United States.

C. F. PENFIELD, who has been in charge of drilling operations in the Bakersfield, California, district for the Shell Oil Company, is in Holland, accompanied by Mrs. Penfield. Before returning to California he will visit the producing properties of the Shell companies in the Far East.

PAUL PITZER, Breckenridge, Texas, has been chosen president of the West Central Texas Oil and Gas Association. **L. S. HALL** of Abilene, Texas, is first vice-president; and **DILLARD HENSON** of Graham, Texas, second vice-president.

IVAN SALNIKOV, division petroleum engineer at Seminole, Oklahoma, for the Carter Oil Company, has been transferred to South Burbank to replace **RAY KOLLAR,** superintendent, whose resignation becomes effective April 1st.

JOHN BURNELL has been transferred from Saginaw, Michigan, engineering-map department to the Porter production office of the Pure Oil Company, relieving **HARRY FROST,** who has been sent to the Greendale district as chief clerk.

JULIUS HERROM, engineer with the Stanolind Oil and Gas Company, has been transferred from the Casper, Wyoming, office of the company to the field office at Midwest, and **HOWARD BARNETT,** engineer, has been sent from the field office to the Casper office.

ROY FRY, who has been general superintendent of the Standard Oil Company's operations in the San Joaquin Valley of California, has been transferred from Taft to the company's main offices at San Francisco. **AL TIETZE** has been moved from San Francisco to Taft to take over Fry's former duties there.

C. K. HOLT, who has been superintendent for the Honolulu Oil Corporation at Elwood, California, has been put in charge of the company's operations at Round Mountain and is making his headquarters at Bakersfield. He exchanges positions with **JOHN MERRITT,** who has been transferred from Round Mountain to Elwood.

H. W. CAMP has been made manager of the refining division of the Empire Oil and Refining Company, a position made vacant by the recent death of **P. M. MISKELL. LOUIS D. MANN** is the new general superintendent, succeeding Camp.

E. B. REESER, president of the Barnsdall Oil Company, Tulsa, Oklahoma, has been looking over company properties in California.

J. A. BERMINGHAM, Los Angeles, vice-president and manager of the California production division of The Texas Company, was a recent business visitor in Texas.

J. L. NICHOLS, production superintendent in Kansas for the Stanolind Oil and Gas Company, has moved his headquarters from Wichita to Tulsa. **RALPH LUDWIG,** petroleum engineer, has been sent to Ellinwood, Kansas.

WARREN L. TODD, independent operator, has moved his West Texas-New Mexico offices to Midland from Big Spring.

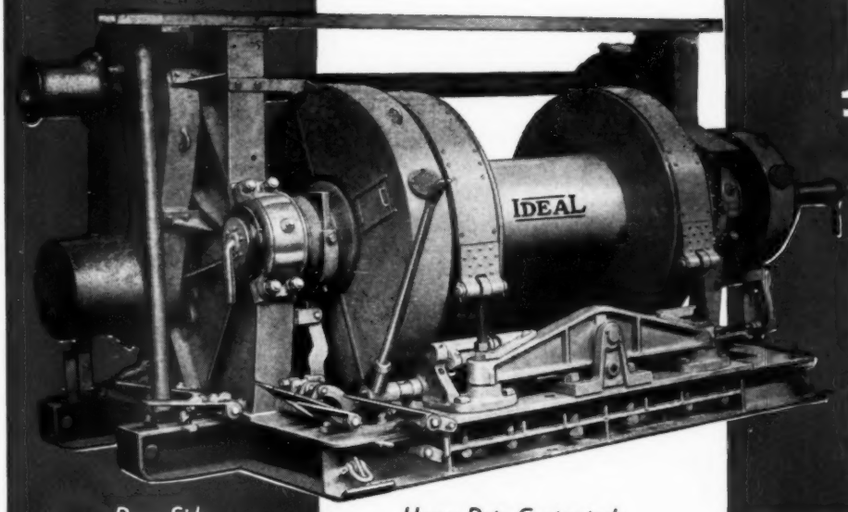
GEORGE S. ROLLIN has resigned as vice-president in charge of production in the Mid-Continent for the Roxana Petroleum Corporation and the Shell Petroleum Corporation. He is succeeded by **A. J. GALLOWAY,** vice-president of the Shell Petroleum Corporation, who is being transferred from St. Louis, Missouri, to Tulsa, Oklahoma.

RALPH D. CURTIS, engineer with the Gulf Oil Corporation, has resigned to become proration engineer and assistant to **JAMES S. NOLAND,** who is in charge of proration matters for the Barnsdall Oil Corporation.

E. E. SWOPE, Beaumont, Texas, has been elevated from the post of assistant general manager of refineries for Magnolia Petroleum Company to the general managership, filling the vacancy resulting from the recent death of **E. E. PLUMLY. JOHN W. NEWTON,** formerly assistant superintendent of the company's Beaumont refinery, succeeds to Swope's old position.

D. L. FRAWLEY, Pittsburgh, Pennsylvania, vice-president of the Barnsdall Oil Company, was a visitor in the Mid-Continent recently.

EMORY N. KEMLER has resigned his position as assistant professor of mechanical engineering at the University of Pittsburgh and severed his relations with the engineering division of the Gulf Research and Development Corporation at Pittsburgh, Pennsylvania, to accept a post with the Gypsy Division of the Gulf Oil Corporation of Pennsylvania. His headquarters will be at Tulsa, Oklahoma.



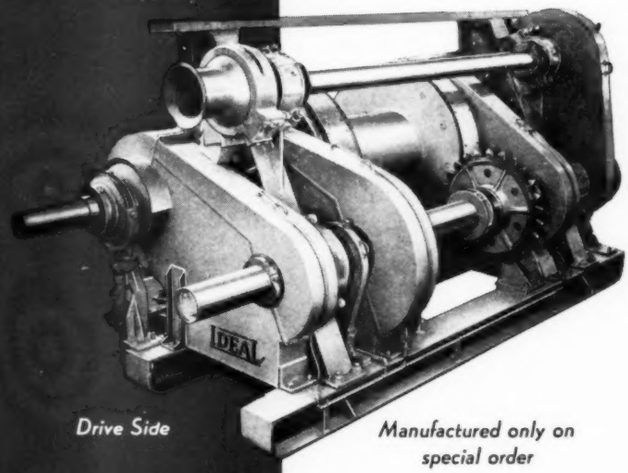
Drum Side

Heavy Duty Contractor's Special

IDEAL

UNIT TYPE

DRAW WORKS



Drive Side

Manufactured only on special order

A 1000 H.P. Unit embodying refinements heretofore unavailable in conventional Draw Works:

MACHINE CUT SPROCKET TEETH

Materially reduces noise and increases the life of the sprockets and chains.

OIL CIRCULATING SYSTEM

Rear member of main frame serves as oil reservoir. Gear pump forces oil to each of the three drum drive enclosures, where it "cascades" over the chains and sprockets.

ROLLER BEARING CLUTCH SPROCKET

All six clutch sprockets are mounted on roller bearings having hardened and ground inner and outer races.

DRUM SHAFT ASSEMBLY

Drum is 26" diameter and 45¾" long. It is a one-piece steel casting, either plain, or grooved for 1", 1⅛", or 1¼" line, as specified.

THE NATIONAL SUPPLY COMPANY

NSCO

National

Personnel of Well Equipment Company, Inc.

The accompanying photograph of the personnel of the Well Equipment Company, Inc., 2023 Semmes Street, Houston, Texas, was made at the annual sales meeting. Reading from left to right are: C. K. Stillwagon, president and general manager, (in the car Master Jimmie Stillwagon); C. H. Lane, vice-president; G. A. Stevens, West Texas representative; A. G. Wilcox, southern Louisiana representative; W. S. Ewers, bookkeeper; D. W. Elliott, southwest Texas representative; S. H. Smith, secretary and treasurer, and Gulf Coast representative; O. W. Sanders, warehouse man. Those with the company not in the picture are Miss Lucile Stenzel, stenographer, Carl Roberts, office man, and Rob Chapman, Northern Louisiana representative.

Since the organization of the company 17 months ago it has experienced a rapid growth. The company was organized by Messrs. Stillwagon and Lane, both well known in the oil industry, for the purpose of representing a select group of manufacturers and their lines, as follows: Hamer Oil Tool Company, Ltd., Long Beach, California; Kibele Manufacturing Company, Dallas, Texas; C. A. Fischer Company, Fort Worth, Texas; Gulf Lubricator Company, Houston, Texas; Boiler Equipment Supply Company, Inc., Oklahoma City, Oklahoma; Great Western Cordage Sales Company, Inc., Orange, California; The Exner-Dodge Packer Company, Coffeyville, Kansas; and Real Fire Burner Company, Tulsa, Oklahoma.

In addition the company manufactures and distributes the Weco Wing Union through supply stores, as they sell all other products, and at this time wishes to announce their recent connection with the Gearench Manufacturing Company, a Houston concern, to distribute Petol products in Southwest Texas, West Texas, and Southern Louisiana. The latter manufactures a complete line of tongs and wrenches.

East Texas Oil Field Directory

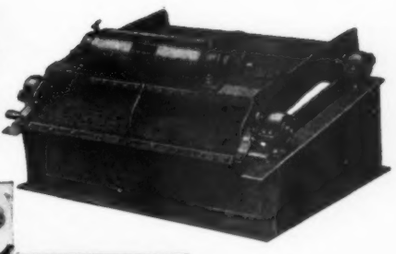
The East Texas Oil Field Directory, 1936 edition, has just been issued by the Wimberly Report Service of Kilgore. G. E. Wimberly, Box 442, is head of the publishing company.

In the directory are listed operators, pipe line companies, refineries, along with their addresses, as well as the names and addresses of the superintendents of the various organizations. In addition, affiliated industries are listed. The price of the directory is $1.50.

and STILL they come!
FLUID PACKED PUMP
performance records marked
NO DOWN TIME!
A pump that remains in the well steadily pumping month after month is the pump that insures maximum ultimate production—and low pumping costs. From far and near comes a steady stream of Fluid Packed Pump performance records bearing notation "No Down Time"—or, in other words, "more profit for producer from each barrel of oil pumped."
HERE'S ANOTHER RECORD of RESULTS!*
A report received February 26, 1936, from a major oil company, shows that a 2" x 18' Positive Pull Type FLUID PACKED PUMP has been steadily pumping 45 barrels daily of clean 26° gravity oil from a depth of 3100 feet since March 18, 1935—almost a year—with No Down Time. A competitive pump was pulled four times in the year previous to the installation of this Fluid Packed Pump.
*Name of company on request.
Pumping Costs Cut—PROFITS INCREASED
After all, it's service like this that you want—and must have—to cut pumping cost and increase your profits. Why not put Fluid Packed Pumps to work for you?
See the FLUID PACKED PUMP section in your 1936 Composite Catalog—or write for full information.

FLUID PACKED PUMP CO.
BOX 64 • LOS NIETOS, CALIFORNIA • U.S.A.
MID-CONTINENT AND TEXAS DISTRIBUTION
FLUID PACKED PUMP CO.—MID-CONTINENT
2 S. E. 29TH ST., OKLAHOMA CITY, OKLAHOMA
Gulf Coast Headquarters: 409 Velasco St., Houston, Texas
London Office: Coventry House, South Place, London E.C. 2, England
A MODERN PUMP FOR MODERN CONDITIONS
Protected by Patents No. 1845474, 1545475, 1549175, 1621046; others pending.

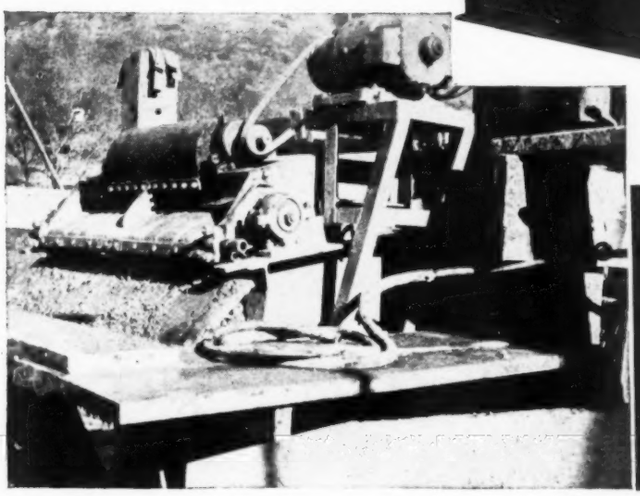
BUILT STRONGER —LAST LONGER!



MUD screening equipment *must* be strong and durable to protect against expensive shut-downs. It *must* have long life to pay dividends on the investment.

McNEELY Vibrating Mud Screens are built stronger and last longer, thus assuring utmost screening efficiency at lowest upkeep costs. Screen cloth life is materially lengthened because the cloth cannot "whip."

McNEELY Vibrating Mud Screens bring new economies to operators. Ask your Supply House or write for Catalog.



SEE PAGE 1279 • 1936 COMPOSITE CATALOG FOR FULL DETAILS

A McNEELY Vibrating Mud Screen saving money for the operator at Bandera, Texas.

The McNEELY Vibrating MUD SCREEN

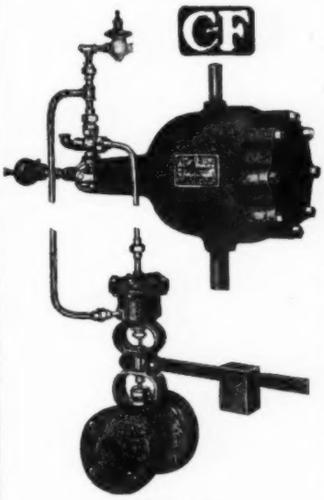
VERNON TOOL CO., LTD.
2740 East 37th St., Los Angeles, Calif., U.S.A.
Gulf Coast and Mid-Continent Representative
BAROID SALES CO., HOUSTON
EXPORT
The National Supply Corp. - Oil Well Supply Co.

HOTEL LASSEN is famous for its food because here it is expertly prepared and served in the most appetizing and refreshing manner. Excellent food, combined with modern accommodations and a comfortable atmosphere of quiet, make the Lassen a desirable home for you while in Wichita. Room rates from $2.00. Conveniently located.

ROY MOULTON, Manager

HOTEL LASSEN
WICHITA, KANSAS

LIQUID LEVEL and Flow in or Out
under positive remote control

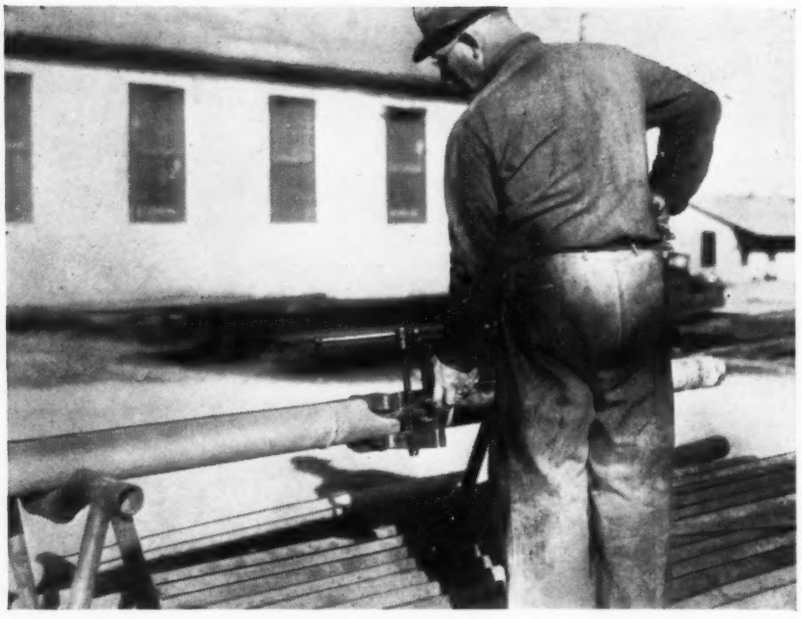


VIGILANT
Liquid Level
REGULATOR

In the operation of Stills, Vaporizers, Bubble Towers, and Dephlegmators, a continuous inlet or outlet flow and a constant level of condensates can be definitely secured by installing a differential-type Vigilant Liquid Level Regulator on the side of the tank, and the control valve on the inlet or outlet line as required. Control works on compressed air, steam, water or gas. Bulletin No. 3113 on request.

THE CHAPLIN-FULTON MFG. CO.
28-40 Penn Ave. Pittsburgh, Pa.

Fitting the device on a 4-in. clamp



By

ROY W. PARKER

Oklahoma Natural Gas Company

Device for Installing Leak Clamps

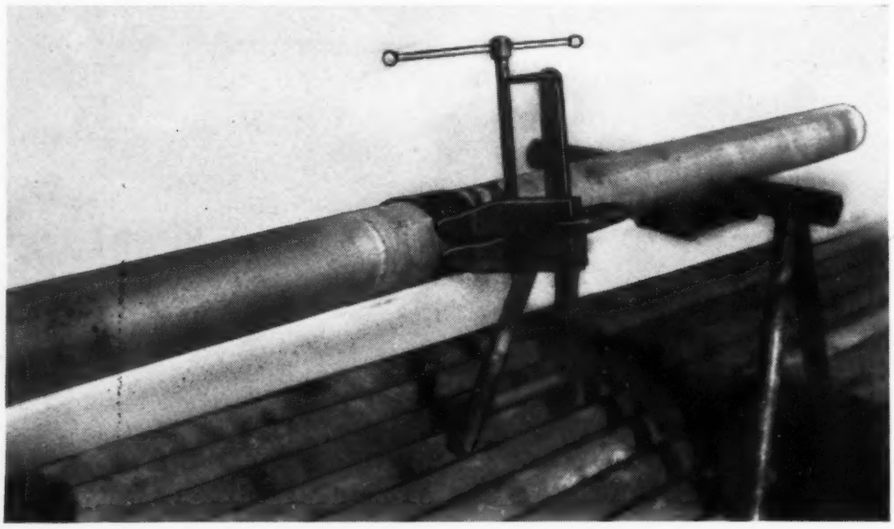
CONCENTRATED corrosion or pitting of pipe lines is often the answer to much un-accounted-for gas. Leaks from this cause are found by different methods and often are repaired in a different way. The maintenance crews of companies using leak clamps to stop such leakage generally experience difficulty in making such repairs.

Not so long ago the general procedure was to bell-hole a pit large enough for two men to work, with a combination wrench fitted over the ends of the clamp and a Stilson type wrench to take-up on the combination until a bolt could be started. This was often a slow and none too successful operation, especially in a muddy bell-hole.

Shown on this page is a device that replaces wrenches, etc., when installing leak clamps. It is quite simple in design and easily fitted on a clamp to be installed. A. W. Kneer, our machine shop superintendent, who made the device, has supplied 23 for the several districts at a cost of approximately $15.00 each. Reports indicate that they will pay for themselves in a short time. Leaks that have taken two men three hours to repair now are repaired by one man in one hour, a saving of four man-hours. Shorter or less expensive bolts can be used, as the lips of the clamp can be brought close together.

The device is particularly useful when working with the heavy 10-gauge steel used in the 6-in., 8-in., 10-in., 12-in., 16-in., and larger clamps, as these clamps must be spread to slip over the pipe and to bring them back to pipe shape requires considerable force.

The device shown here on a 4-in. pipe is of suitable size and has the following dimensions: Overall length 10 in., height 6½ in. (3-in., center screw to pipe and 3½-in., center screw to top of slide-bar). Slide-box is 1½-in. by ½-inch. The screw is made of ¾-in. axle steel with a left-hand thread, and the handle on screw of ⅝-in. round iron. The jaws are 4⅛ in. wide at top and 2½ in. between the teeth. The carrying handle is of ½-in. by 10½-



Ready for a short bolt

A close-up of the device on a 4-in. pipe

in. round roll. The two main body parts are slotted at the top, the slide-bar inserted, top-welded and rounded.

New Officers for Clark Bros. Company

Clark Bros. Company, of Olean, New York, one of the leading manufacturers of oil industry engines and compressors, have announced new officers, elected following the recent death of J. S. Reid, president of the company.

The new officers of the company are C. Paul Clark, president; John B. O'Connor, vice-president; and F. H. Light, secretary and treasurer.

PAUL CLARK

J. B. O'CONNOR

The company's new president, Paul Clark, is a son of one of the founders of the company, William Clark, and has been responsible for the development of the company's oil field engine and compressor equipment. Clark Bros. Company originally was one of the largest builders and exporters of saw mill equipment and stationary steam engines in the country. The company is still a large maker of saw mill equipment, though its largest volume now consists of oil industry engines and compressors.

F. H. LIGHT

The new vice-president, "Johnny" O'Connor, has been with the company since 1929, having started as manager of the Texas office. He was advanced to the position of sales manager, in 1932, with headquarters at Olean, and as vice-president continues to be director of sales.

Light advances to his present position from that of assistant secretary and treasurer. Announcement also is made of the promotion of D. K. Hutchcraft from the sales staff to Mid-Continent manager with headquarters at Tulsa.

The
OIL BANK
OF AMERICA

is more than a name

IN its co-operation with oil activities, the National Bank of Tulsa is outstanding. Examine the records. You will find its financial support behind leasing, drilling, storage, transportation, refining, and marketing projects throughout the Mid-Continent fields.

Whenever and wherever the industry or the individual needs money for new or extended developments, the officers of the National Bank of Tulsa are glad to go over the proposition.

They are experienced in financing the oil industry and know your needs. If the loan meets the requirements of sound banking, you may be sure your application will be approved.

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

NATIONAL
BANK
OF
TULSA

TULSA, OKLAHOMA

The Oil Bank of America

International Petroleum Exposition to Have Extensive Array Scientific Exhibits

The ninth International Petroleum Exposition, May 16th to 23rd, at Tulsa, Oklahoma, will have the greatest array of scientific exhibits in its history, according to W. G. Skelly, president. The Exposition, through its scientific and technical committee, headed by W. A. Schlueter, is assembling an array of new and unusual scientific devices that will occupy approximately half the Scientific Building. Exhibitors who have purchased space also will show many new scientific devices in addition to the special scientific exhibit.

Approximately 95 percent of the Exposition exhibit space, which covers 15 acres of booths in the five buildings and open-air tracts, is now contracted for. "The most elaborate display they have ever had, single exhibits valued at $25,000 and $50,000 being common, are being planned by the exhibitors," Skelly says.

"Attendance at the ninth International Petroleum Exposition may set a new record," he states. With hotels in the city filling up, the Exposition has formed a Housing Bureau headed by Earl Sneed, to make reservations for visiting oil men. Oil men wishing rooms should write the Housing Bureau in care of the Exposition.

With such meetings as the American Petroleum Institute, Natural Gasoline Association of America, Independent Petroleum Association of America, and some 15 other oil associations convening in conjunction with the Exposition, the oil man cannot afford to miss the Exposition, it is pointed out.

The exhibits alone represent at the present time manufacturers of oil equipment in 26 states of the Union and the oil man will have the opportunity of seeing the latest ideas, inventions, improvements, and new devices in the oil business within one week at the Exposition.

"Old timers" in the oil industry will be honored at the Exposition, as usual. A plaque in honor of the pioneers who made the present day industry possible will be placed on a replica of the old Drake well and the names of pioneers in attendance and those submitted to the old timers committee will be placed in a special book as a permanent record.

At the inventors' congress devices still on blue print, still in model form, and many of which have not been manufactured, will be displayed. Any one having such devices should write the scientific committee of the Exposition, giving a description. All devices selected by the committee are exhibited free.

Tulsa oil companies will see that visiting oil men are cared for properly and will have every convenience at their command. Hosts have been appointed by the Exposition, and each host will have the personnel of from ten to 15 oil companies to assist him on the day designated. The hosts, as announced by W. B. Way, general manager of the Exposition, are:

W. G. Skelly, opening day, Saturday, May 16th, refiners day.

W. K. Warren, president of the Warren Petroleum Company, Sunday, May 17th, natural gasoline day.

Ralph B. Pringle, vice-president and general manager of the Tide Water Oil Company, Monday, May 18th, production day.

R. O. Dietler, vice-president of the Stanolind Crude Oil Purchasing Company, Tuesday, May 19th, pipe line day.

R. W. McKowell, vice-president of the Mid-Continent Petroleum Corporation, Wednesday, May 20th, marketers' day.

A. O. Olson, president of Olson Drilling Company, Thursday, May 21st, drilling contractors' day and purchasing agents' day.

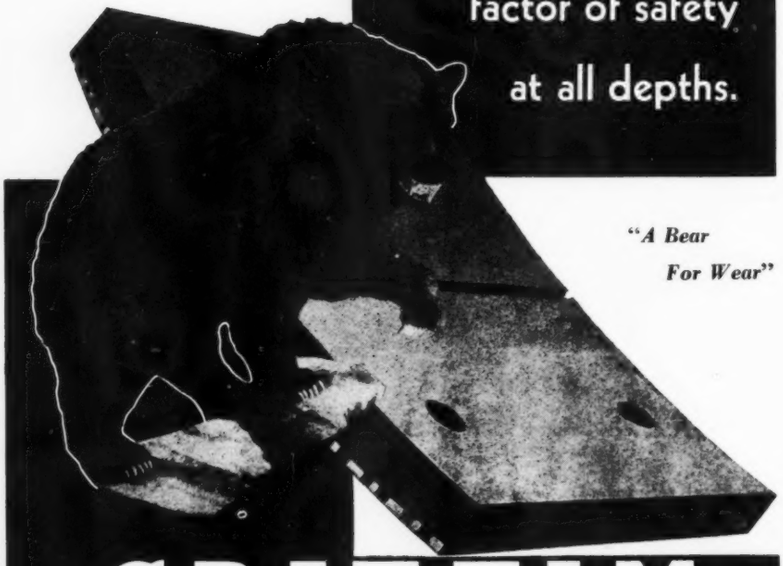
W. R. Francisco, secretary-treasurer of

There is only one Grizzly. Be sure you get the genuine by specifying GRIZZLY Full-Moulded BRAKE BLOCKS.

E. M. Smith Company

600-650 South Clarence St., Los Angeles, California. Sold in the Mid-Continent and Gulf Coast by: Continental Supply Co. and T. T. Word Supply Co., Inc., Houston, Texas. In All Their Stores. Export Office: Continental Emsco Co., 30 Rockefeller Plaza, New York City. :: ::

GRIZZLY'S exceptional braking efficiency permits faster running-in and pulling out, with the highest factor of safety at all depths.



"A Bear For Wear"

GRIZZLY

FULL-MOULDED

BRAKE BLOCKS

Deep Rock Oil Corporation, Friday, May 22nd., geologists' and oil scouts' day.

E. B. Reeser, president of Barnsdall Oil Company, Saturday, May 23rd, general oil industry day.

Pittsburgh Equitable and Merco Nordstrom Add to Sales Staff

The Pittsburgh Equitable Meter Company and its subsidiary, the Merco Nordstrom Valve Company, announce the appointment of Roy R. Bush and Earl P. Martin to their sales staff. After leaving the University of Oklahoma, Bush received his early training in the field with the Page Interests at Sand Springs, Oklahoma, followed by employment with Sprague and Neely at Borger, Texas. He has obtained extensive production, pipe line, and warehouse experience with the Independent Oil and Gas Company at Earlsboro, Oklahoma, the Oklahoma Natural Gas Corporation at Tulsa, and the Texas Pipe Line Company.

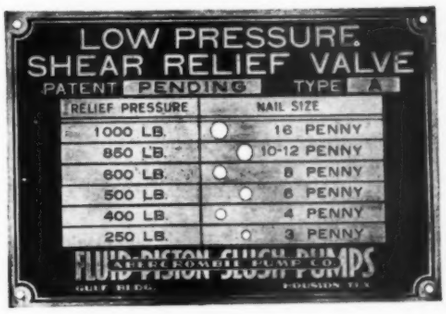
EARL P. MARTIN

ROY R. BUSH

Martin, a native of Kentucky, graduated from the University of Kentucky in 1924, receiving a degree of B.S. in mining engineering. His first employment was with the Foxboro Company, with whom he spent four years at Tulsa and one year at Houston, in the capacity of sales engineer. For the following three years he was in charge of the construction and maintenance of the city gate measurement station at Butte, Montana, for the Phoenix Utility Company and the Montana Power Gas Company.

Both Messrs. Bush and Martin will work out of the Tulsa office of the meter and valve company and will sell and service Emco gas and oil meters and pressure regulators, and Nordstrom lubricated plug valves.

talk about
SIMPLICITY



This is the low pressure SHEAR-RELIEF Valve, for gathering pumps, or similar service.

No One Can Misunderstand Setting Directions Like These!

All necessary details of operation of the Abercrombie SHEAR-RELIEF Valve are right on the name-plate, so you can't go wrong in setting it. Notice the relieving pressures, and the size nail which shears at each pressure. Notice also the nail gauge, which eliminates any chance of mistaking nail size. Notice, too, the simplicity of inserting the nail on the SHEAR-RELIEF Valve shown at the left.

FLUID-PISTON SLUSH PUMPS
ABERCROMBIE PUMP CO.
GULF BLDG. HOUSTON TEX.

The CAVINS *plus* CAVINS SERVICE
Assures successful cleanout and fishing jobs.

CAVINS
3 Tools *In One*

A BAILER
A FISHING TOOL
A PERFORATION
WASHER

Cavins service consists of more than just the rental and delivery of efficient tools to your well. First, you are supplied with a tool and accessories especially adapted to your individual job. An experienced service man instructs the crew how to run The Cavins to get best results, and remains on the job until successful operation and recoveries are assured. Should unforeseen difficulties develop after he leaves, other service men are available immediately for assistance. The entire Cavins organization with complete facilities and equipment for every type of bailing, cleanout and fishing job, are available 24 hours a day to insure successful completion of your job in record time, eliminating loss of time, production and exponse. Ask us about Cavins equipment and service for any kind of cleanout or fishing job.

THE CAVINS COMPANY

2853 Cherry Avenue. Phone 414-14. Long Beach, California
Cable Address: "Cavins, Long Beach" *Foreign Representative:* R. J. Eiche

Bakersfield, Calif., 3800 Chester Ave. Phone 1779J
Taft, Calif., 200 Center St. Phone 78
Goleta, Calif. Phone 8213
Santa Paula, Calif. Phone 234
Houston, Texas. Phone Wayside 1451
Kilgore, Texas. Phone 753
Pampa, Texas. Phone 1220
Oklahoma City, Okla. Phone 3-6441
Wichita, Kansas. Phone 45-449
Lyons, Kansas. Phone 227

Houston Oil Show to Introduce Many New Equipment Designs

Plans have been completed for the seventh Oil Equipment and Engineering Exposition, to be held in Convention Hall at Houston, Texas, April 20 to 25 inclusive. Many special features have been arranged to make the Houston show entertaining as well as instructive.

According to E. G. Lenzner, general manager of the Exposition, equipment for all branches of the petroleum industry will be on display. The exhibits will show the latest designs in tools and machinery for exploration, drilling, production, refining, natural gasoline manufacture, pipe line operations, and transportation of products and materials.

Most of the tools and machinery exhibits will utilize moving equipment to simulate field, or working, conditions. This will apply to the displays within the exhibition building as well as to those on the outside spaces adjacent to the building where complete operation can be shown. On the outside space also will be conducted many demonstrations.

The new invention exhibit, inaugurated several years ago, will be enlarged. Free space is given to inventors and patentees of oil tools for the purpose of showing models and designs of new equipment.

The annual First-Aid Contest, which is held throughout the week, continues to claim intense interest. Most of the teams have been preparing for this event for several weeks and rivalry is keen.

Daily trips to near-by fields and plants have been arranged for visitors from other parts of the country and for representatives of foreign oil companies. The Exposition, being situated in the center of a territory where a most extensive use of modern methods and equipment is to be found, attracts many out-of-the-state visitors who take advantage of the opportunity to study the tools and machinery in application under actual field conditions. Entertainment features will include a golf tournament, daily events for the ladies, and the annual banquet.

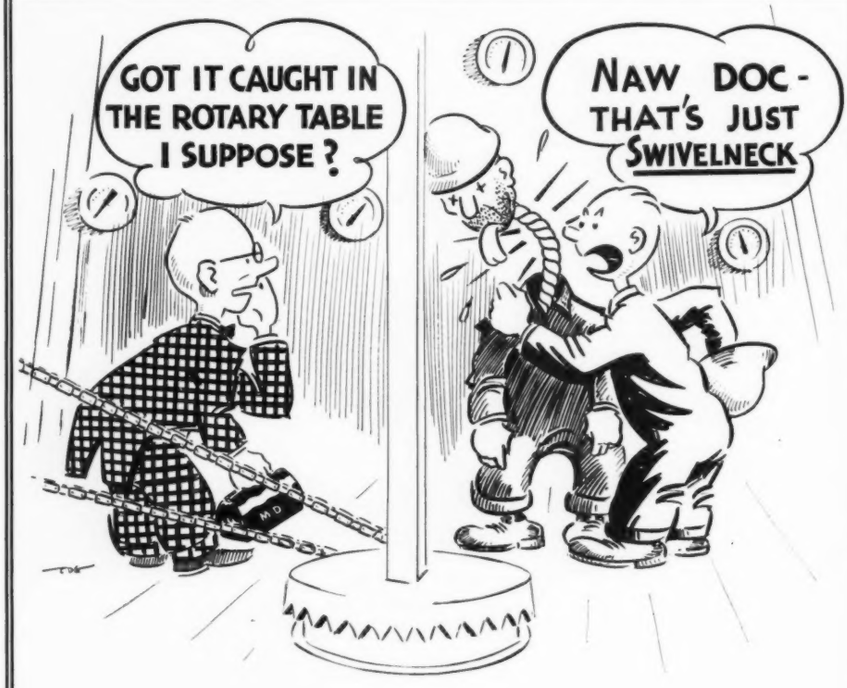
Mr. Lenzner states that a large attendance of oil men from all parts of the United States and from foreign countries is expected at the Houston show.

Free tickets are provided for oil men so that they can attend as often as desired and make a thorough study of all the tools and machinery in which they are interested. The exhibitors are provided with a supply of such tickets in addition to those furnished direct to the various oil companies.

The equipment to be displayed will include specialties from all parts of the United States. To assist the manufacturers, arrangements have been made for reduced freight rates on such equipment.

Reduced fares for visitors also have been made available. To obtain the low fare offered, an identification certificate will be necessary and it is urged that applications for these certificates be made immediately to the Exposition management in the Petroleum Building at Houston, Texas. Arrangements have also been made with the hotels to maintain their regular rates. Reservations for rooms also are being taken care of by the management.

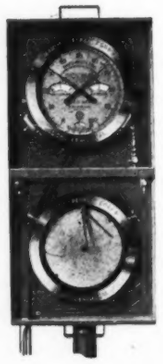
Arrangements have been made for the housing and entertainment of foreign visitors. Special plane service from South American headquarters to Houston is planned in order to reduce traveling time from Venezuela and Colombia.



It's no joke, Swivel Neck is really worse than you think. It is a malady caused by trying to watch too many drilling gauges at once, scattered from one end of the rig to the other.

"QUINTUPLEX"
is the only cure for Swivel Neck!

"Quintuplex" brings all the gauges into one case, close up to the driller's eyes and shows him instantly every change in drilling conditions without nerve, "neck", or eye strain.



THE WEIGHT INDICATOR
MARTIN DECKER CORP.
LONG BEACH CALIFORNIA

San Joaquin Valley: A. F. McQUISTON, Oildale, California
Mid-Continent Distributor: REED ROLLER BIT COMPANY, Houston, Texas

Trade Personals

JOHN A. WORTHINGTON, manager, industrial sales and engineering, American Hammered Piston Ring Company, Baltimore, Maryland, is making a business trip through the Mid-Continent area.

C. B. TAYLOR, member of the Black, Sivalls and Bryson organization, has been transferred from Oklahoma City to the Tulsa office of the company and made sales engineer.

WALTER H. WIEWELL, manager of tubular sales, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania, recently made a tour of the Mid-Continent and Gulf Coast areas.

J. R. ROBERTS, formerly of Tyler, Texas, is in charge of the new branch office of Lee C. Moore and Company at Corpus Christi, Texas.

GEORGE B. MORRIS, president of the Bradford Motor Works, Bradford, Pennsylvania, recently completed a business trip through the Mid-Continent and Gulf Coast areas.

J. HAROLD ADKISON has resigned as secretary of the Mid-Continent Petroleum Division of the American Society of Mechanical Engineers to accept a position with Dowell, Inc. His headquarters for the present will be at Tulsa.

A. D. BROWN has been appointed manager of Allis-Chalmers Manufacturing Company's Los Angeles district office to fill the vacancy caused by the recent death of **BOYD ANDERSON.** Brown for many years was manager of the company's Buffalo district office.

H. E. WEISS has been appointed manager of Allis-Chalmers' Buffalo district office. He formerly was manager of the company's Salt Lake district office.

MRS. ROBERT CARNES, wife of the East Texas representative of the Union Wire Rope Corporation, at Kilgore, died recently. Burial was at San Angelo, Texas.

Opens Houston Division Office

The S. M. Jones Company has opened a Houston division office in room 1005 of the Sterling Building. L. J. Pundt, division manager, is in charge, and C. E. Buchner is attached to the division as a sales engineer.

This office is equipped to handle field engineering department requests and to give producers complete information on sucker rods, and pumping conditions affecting sucker rod life.

Bill McArt Bowling Champion of Oklahoma

Selling Emco meters and Nordstrom lubricated plug valves for the Pittsburgh Equitable Meter Company and its subsidiary, the Merco Nordstrom Valve Company, isn't the only thing W. J. "Bill" McArt is now noted for in Oklahoma. In addition to being a champion in the selling game, and a vocalist of note, Bill now bears the title of State Singles Bowling Champion.

Admittedly a dark horse, he proved he could turn on the steam against the best of 128 entries in the third annual Oklahoma City *Times* singles bowling tournament. Consistent game scores of 243, 199, 207, 222, 234, and 187 gave McArt the top figure of 1294, the second highest six-game total on the records.

But don't with a ROTARY HOSE

Deep holes and high pressures demand safe equipment.

It is futile to use large pumps, 4" fluid passage swivels, full hole tool joints and larger circulation area in bits and reamers and still use old style 3" rotary hose. The Chiksan 4" Super Rotary Hose is especially designed and built to keep in trend with modern drilling equipment. It features full 4" Fluid Passage. Safe, Flexible, Economical.

Chiksan 4" All Steel Rotary Hoses are being used on the deepest wells at Kettleman Hills and other high pressure fields throughout the world.

Don't gamble with ordinary hose. When you need high pressures to keep circulation, protect your workmen and your well with the positive safety factor of Chiksan Steel Hose.

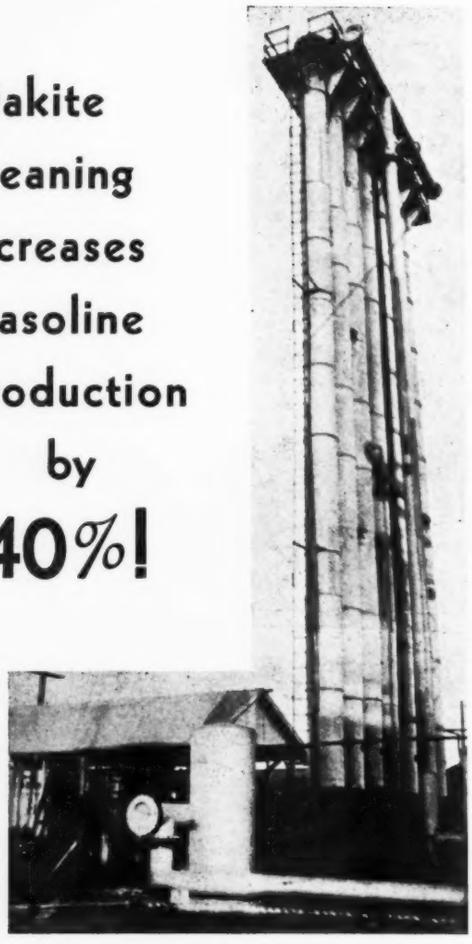
Chiksan

CHIKSAN OIL TOOL CO. LIMITED

FULLERTON, CALIFORNIA — GULF ENGINEERS INC., HOUSTON TEXAS

PACIFIC NORTHWEST DISTRIBUTOR — E. C. GRIFFIN 401 8th AVE. NORTH, SEATTLE, WASH.

Oakite Cleaning Increases Gasoline Production by 40%!



Circulating an Oakite solution through the seven absorption towers of a leading gasoline refinery more than paid for itself in the two weeks' operation following the cleaning. Gasoline production was increased 40%.

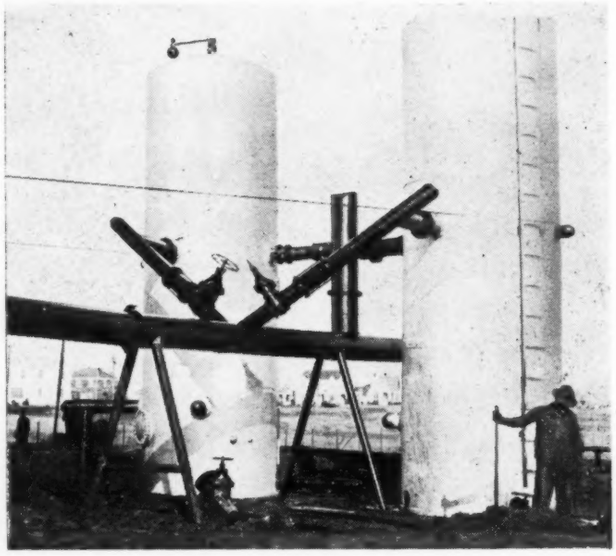
Whether it's cleaning absorption towers, oil coolers or other heat exchange equipment, you can rely on the recommendations of the local Oakite Service Man for methods of doing a job that will be quick, effective and economical.

Write today for interesting information on all oil producing and refining cleaning operations. No obligation.

Manufactured only by
OAKITE PRODUCTS, INC., 48 Thames Street, New York, N. Y.
Branch Offices and Representatives in All Principal Cities of the U. S.

OAKITE
TRADE MARK REG U.S. PAT. OFF.
SPECIALIZED INDUSTRIAL CLEANING MATERIALS & METHODS

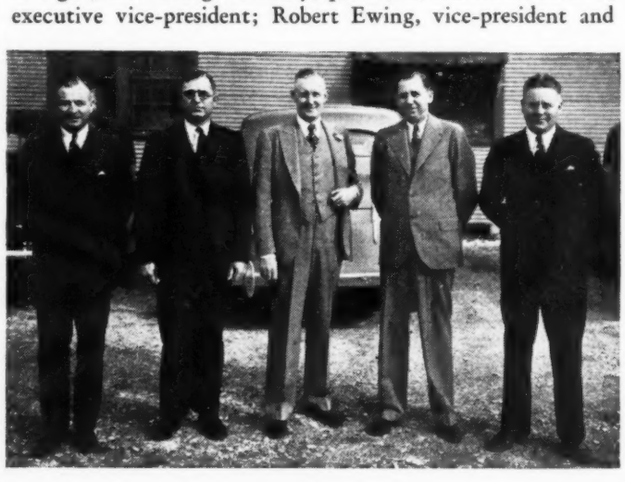
Oil-Gas Separator We With Sand in Ok



Oil-gas separator hook-up on British American Oil Producing Company's Piersol No. 1 in Oklahoma City field near State Capitol

Houston Oil Field Material Company Elects Officers

The Houston Oil Field Material Company, Houston, Texas, recently elected new officers and directors. The officials are shown in the accompanying photograph and, reading left to right, are: George O'Leary, president; Ed H. Robertson, executive vice-president; Robert Ewing, vice-president and



assistant secretary-treasurer; J. E. Peters, secretary-treasurer; and A. W. Waddill, a director. M. "Bing" Manning, who is not in the picture, was elected a vice-president and director. The four officers shown here also were chosen to the board of directors.

ll Hook-Up for Coping lahoma City Field

A DEPARTURE from standard practice was followed by the British American Oil Producing Company in designing the hook-up from the sand trap on the casinghead to the battery of the two oil-gas separators on its Piersol well No. 1 at Oklahoma City. This well has come into the spotlight because of its being the nearest producing well to the Oklahoma State Capitol Building.

Although usual practice was followed in placing a sand trap just above the master gate valves, a 15-in. line extends from this unit to the separators and the manner in which the sand cushions are designed differs from the majority of flow-line hook-ups. This 15-in. line extends horizontally from the outlet of the sand trap on the casinghead and is supported by a series of A-frames the tops of which are welded directly to the 15-in. pipe.

There are two inlet connections to each separator and these come off at two separate points in the main line as shown in the accompanying photograph. The first take-off is constructed at a direct angle to the line fitted with the gate valve and the pipe coupling, the latter to take up the shock of the line slip. This connection terminates in an extension beyond where the line to the separator takes off so that the fine Wilcox sand will slip up the pipe and form its own cushion against which the sand that follows will impinge and thus prevent abrasion and cutting out of the fittings at abrupt turns.

As can be seen from the photograph the second take-off to the separator is made from a common riser, also at right angles to the main line, with an extension at the top that serves to hold a cushion of sand as in the first connection. The main line also extends a short distance beyond the point where the second take-off is, and forms another cushion.

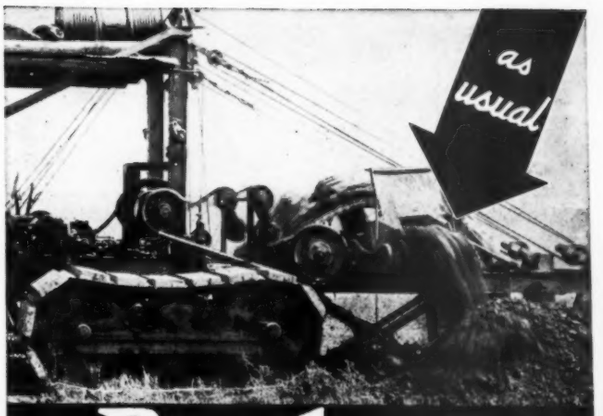
According to C. V. Sidwell, general production superintendent of the British American, this type of flow-line connection has proved quite successful in use and similar ones are being made to be attached to all other wells drilled in this area. It is planned to have all units interchangeable so that they can be transferred from one location and attached to the separator battery of another well without refitting or welding when it is necessary to connect up a well in a hurry.

W. C. Morgan Joins Sales Staff Rector Well Equipment Company

W. C. MORGAN

W. C. Morgan, formerly with the Hughes Tool Company as manager for Oklahoma and Kansas, has been made representative in those two states for the Rector Well Equipment Company, Inc., of Fort Worth, Texas. His headquarters are at 310 Thompson Building, Tulsa, Oklahoma.

Morgan has been in the supply business for a great many years and is well known throughout the industry.



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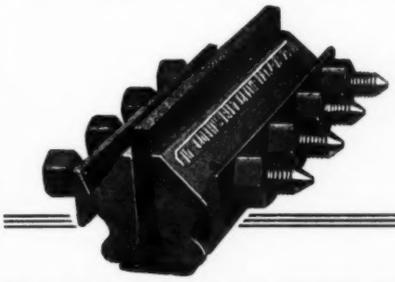

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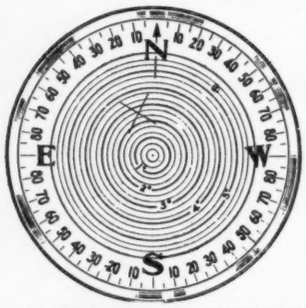

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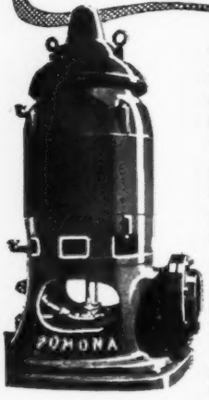

"We like the POMONA because we do not have to pull it up for repairs, or other troubles, and have no repair expense."

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POMONA TURBINE PUMPS

Construction of 70-mile Line for Transportatio

TO convey natural gas to the City of London, Ontario, the Union Gas Company of Canada, Ltd., recently completed a pipe line to that point from the Dawn field in Lambton County. The line, approximately 70 miles in length, crosses rolling farm land, and during its construction it was necessary to make four river crossings. The size of the steel pipe used varied from 4½ in., up to 10¾ in., there being 52 miles of 10¾-in. O.D. pipe, 14 miles of 8⅝-in. O.D., and a miscellaneous amount of 4½-in. O.D. stock.

Laying an approach to a river crossing

In laying the line the 20-ft. sections of pipe were connected by means of Dresser couplings, and the whole coated with Barrett primer and enamel. A total of 17,166 couplings were used, as follows: 13,030 10¾-in. O.D. couplings, 3526 8⅝-in. O.D., and 610 4½-in. O.D., all being Style 38. Line pipe was manufactured by Page Hersey Tubes, Inc.

Construction was under the direction of C. E. Steele,

Midwest Equitable Combines Sales Meeting and Short Course

The representatives of the Midwest Equitable Meter Company, a division of Pittsburgh Equitable Meter Company, recently attended a combined sales meeting and short course at the company's Tulsa plant.

Sales and service problems were discussed generally, and representatives were called upon to explain the construction and use of each of the company's products. A. J. Kerr, Midwest's general manager, was in charge of the meeting and reports that those in attendance unanimously agreed that everyone was extremely benefited.

Mile Coupled Line
n of Natural Gas

general superintendent of the Union Gas Company of Canada, Ltd., and R. L. Bevan, general manager of the Natural Gas Division of the company. The 10¾-in. portion of the line was connected and buried in the ditch without any pressure test whatsoever being made to determine the tightness of the couplings.

The line is being operated at a working pressure of approximately 300 lb. per sq. inch.

Pipe on skids above ditch ready to be lowered in

Miller Sand Pump Co. Moves Main Office and Plant to Oklahoma City

The main office and manufacturing plant of the Miller Sand Pump Company is now at 1520-24 S. E. 29th Street, Oklahoma City, Oklahoma. The Sapulpa plant that has been the headquarters of the company for the past 12 years will be maintained as a branch.

The reason for the move to Oklahoma City was to better the shipping facilities and enlarge the manufacturing plant to take care of increased output.

A year ago the Miller Sand Pump Company opened its first branch at Kilgore, Texas, to serve the East Texas field.

The Miller Sand Pump Company is now making several types of sand pumps to meet all conditions and have illustrated these various types in their new folder, No. 56.

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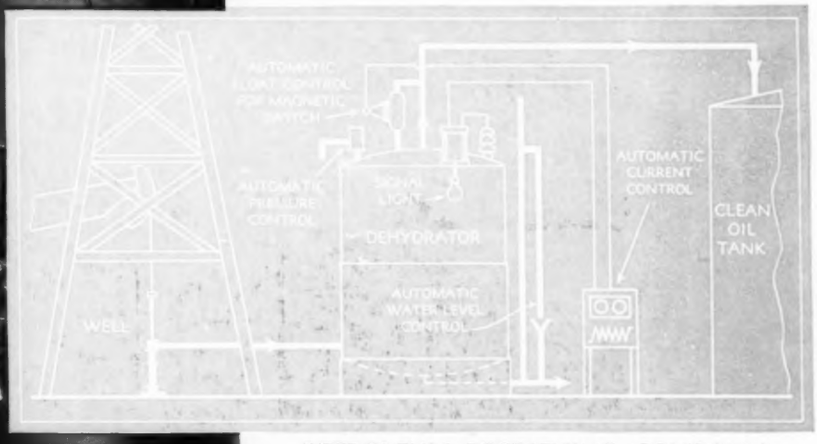

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